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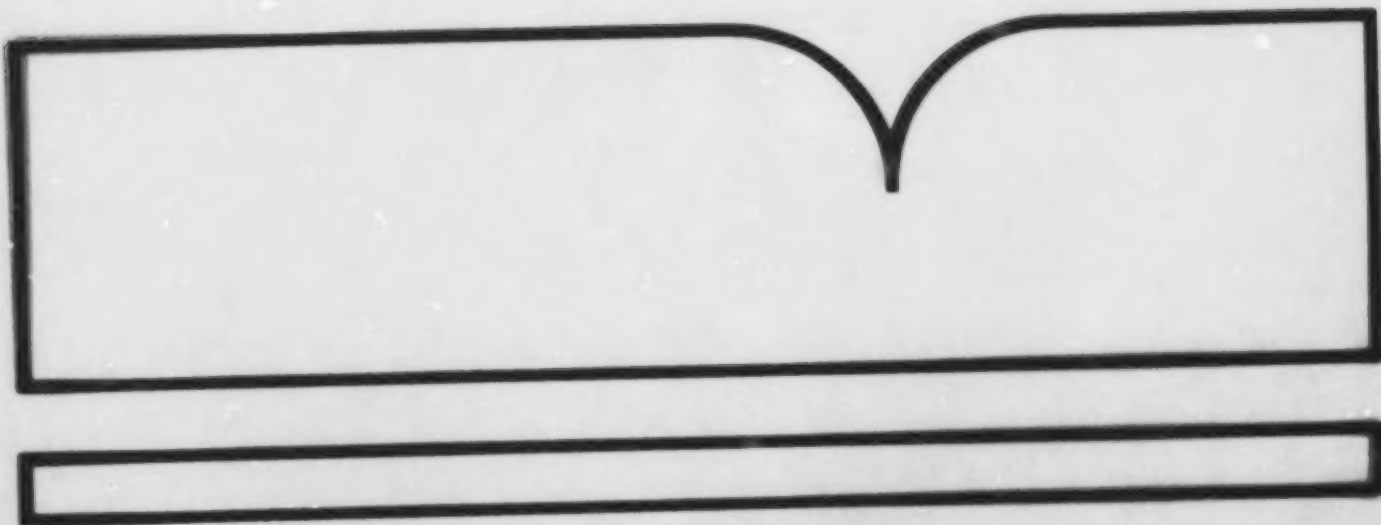
Guidance Document for Cleanup of
Surface Tank and Drum Sites

Camp, Dresser and McKee, Inc., Boston, MA

Prepared for

Environmental Protection Agency, Washington, DC.

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Guidance Document for Cleanup of Surface Tank and Drum Sites

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U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL
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SPRINGFIELD, VA. 22161

**GUIDANCE DOCUMENT FOR CLEANUP
OF SURFACE TANK AND DRUM SITES**

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FOREWORD

A U.S. EPA 1982 survey of disposal practices at uncontrolled hazardous waste sites indicated that over 20 percent of the sites surveyed had drum related problems (EPA, 1983). Although remedial action has been implemented at many of these sites, these problems still remain a major threat to the public health and environment. This guidance document was prepared to assist on-scene federal, state and local officials and private firms that plan and implement remedial actions at National Priorities List (NPL) sites which contain hazardous wastes in surface tanks and drums.

The primary purpose of this document is to provide guidance on carrying out concurrent remedial planning activities and accelerating project implementation for the cleanup of surface tanks and drums containing hazardous waste. This document is designed to be used in conjunction with EPA's guidance documents on conducting remedial investigations and feasibility studies (EPA 1985a,b).

This guidance manual will provide the user with a systematic approach to remedial action for hazardous wastes stored in tanks and drums. However, there are many unique and potentially hazardous conditions on tank and drum sites which require very specialized considerations. This manual does not substitute for the services of a competent professional but is intended to serve as a comprehensive planning and technical guidance tool.

1.0 INTRODUCTION

1.1 PURPOSE

This guidance document addresses remedial actions for the cleanup of surface tanks and drums containing hazardous wastes, as well as grossly contaminated soils associated with the tanks and drums. Guidance is provided for a limited remedial investigation (limited RI), limited feasibility study (limited FS), and contracting procedures. A limited remedial action addresses one "operable unit" at a site that, in the estimation of the lead regulatory agency can be investigated, evaluated and implemented in a relatively short time period. An operable unit is one definable problem area or source of contamination at a site that can basically be addressed independently of other site issues/problems. It can typically be thought of as one piece of the total remedial action at a site.

This is one of three guidance documents on specific remedial actions. The second guidance document is for cleanup of surface impoundments (e.g., pits, ponds, and lagoons). The third addresses development of alternative water supplies. All three manuals may be applicable at a complex site.

While the term "remedial action" is used, this document applies either to removal or remedial actions, since both require a similar decision process. Limited RI/FS are typically the first steps in the remedial response at a National Priorities List (NPL) site and must be consistent with the long term remedy. Remedial actions, as defined by the National Contingency Plan (NCP) in Section 300.68(a), "... are those responses to releases on the NPL that are consistent with a permanent remedy to prevent or mitigate the migration of a release of hazardous substances into the environment." Any remedial action contemplated for implementation at a site must be cost-effective, stabilize the situation, prevent or limit the extent of contamination, and/or provide temporary containment.

Depending on the urgency of response, removal actions may be taken without the preparation of a limited RI/FS, although many of the issues addressed in this document will be assessed in an expedited manner.

A typical limited remedial investigation/feasibility study of this type should take 5-7 months to complete, if sampling is required to supplement existing data. For planning of a single operable unit, one can assume a limited RI may last 4-5 months while the limited FS should be completed in 1-2 months. These time estimates are very general and can vary considerably depending on many factors. Typically the RI and the FS can be performed concurrently, with the limited FS finishing shortly after the end of the limited RI.

1.2 INTENDED USER

This guidance manual is intended to be an aid to state and federal staff and private firms for the implementation of a remedial action for the cleanup of hazardous wastes contained in above-ground tanks and drums. The manual is informative rather than prescriptive in nature. The basic objectives are to provide a concise description of the necessary steps to implement surface remedial actions for the cleanup of tanks and drums within the provisions of the NCP.

It must be emphasized that this guidance is not to be used as an absolute reference. It should be supplemented with other EPA guidance documents and technical reports/references as appropriate. Refer to Section 5.0 for references relevant to the performance of a limited RI/FS. This manual should be used under the direction of an engineer or scientist experienced in hazardous waste remedial projects or equivalent.

Revisions of this manual will be provided, as necessary, to assure compliance with the NCP. Revisions will be made available through EPA for intended users.

1.3 ORGANIZATION OF GUIDE

This manual is organized into three major sections: (1) limited remedial investigation, (2) limited feasibility study, and (3) contracting procedures. These sections represent major activities to be conducted for the cleanup of surface tanks and drums. A detailed review of the steps to conduct a remedial investigation to estimate the characteristics and quantities of those above-ground wastes stored in tanks and drums is presented in Section 2.0. The feasibility study steps are presented in Section 3.0; these steps will lead to the evaluation and recommendation of a cost-effective and environmentally sound remedial alternative for wastes stored in drums and tanks. Contracting procedures, presented in Section 4.0, include a review of typical remedial design and remedial action issues that may be unique to tank and drum sites.

The guidance presented in this manual represents a compilation of existing approaches derived from similar remedial actions implemented at many sites where tanks and drums were handled as a single operable unit. However, it will be necessary to tailor this approach to meet the user's particular needs and the site specific characteristics.

Flow diagrams have been developed to present a logical sequence of activities for the implementation of this type of remedial action. The flow diagrams present the major activities for remedial investigation and feasibility study. The diagrams are located at the beginning of each major section. Each major activity on the flow diagrams is denoted by a rectangle. Diamonds represent decision points and circles indicate starting and ending points for each phase of the entire project. These activities are cross referenced by number to the text in this manual. For example, the activity "Conduct Summary Evaluation" is referenced to Section 3.4.1 in the text, which details the necessary steps to implement this activity. The user may start anywhere on the flow diagram as long as the predecessor activity has been completed.

The execution of a limited RI/FS for a single operable unit is designed to be very flexible in practice. While many of the component activities are similar to a full RI/FS the user should tailor the approach based upon site specific conditions and other previous and/or ongoing remedial action activities. A limited RI/FS for a surface tank and drum site could be initiated during the execution of a full RI/FS or in parallel with other limited RI/FSs (e.g., alternative water supply activities).

2.0 LIMITED REMEDIAL INVESTIGATION

After a decision has been reached to evaluate surface tank and drum cleanup activities at an NPL site, a limited remedial investigation (limited RI) should be performed to provide the information necessary to further define the site, provide the basis to evaluate conditions on the site, and to develop a remedial program to mitigate potential adverse public health and environmental impacts. The four main components of a limited RI are:

1. Develop site description and data base (Section 2.1)
2. Site familiarization and project approach (Section 2.2)
3. Perform initial site characterization (Section 2.3)
4. Conduct detailed field investigation (Section 2.4)

A description of these tasks and the associated decision points are presented below. The logic flow diagram for the RI is presented in Figure 2-1.

2.1 DEVELOP SITE DESCRIPTION AND DATA BASE

The initial component of the limited RI is to obtain available data on site conditions (e.g., the nature, amount, and container condition of tank and drum wastes on-site and unique site features) and to make an initial evaluation of these data related to cleanup activities for the site.

2.1.1 OBTAIN AVAILABLE DATA

Purpose

Data are collected for the following reasons:

- To better define site conditions so that a health and safety plan and sampling plan can be prepared (Section 2.4)

Figure 2-1. Guidance flow diagram for surface tank and drum limited remedial investigation.

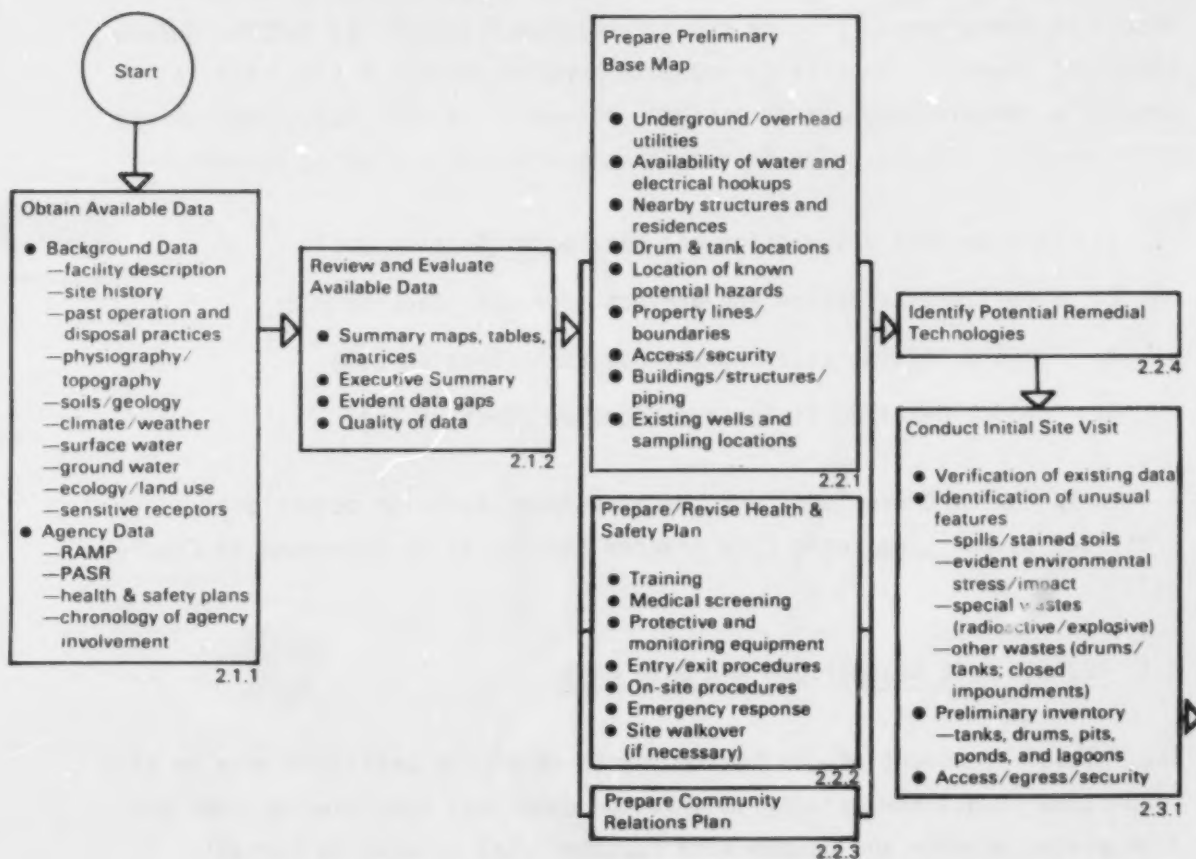


Figure 2-1. (continued)

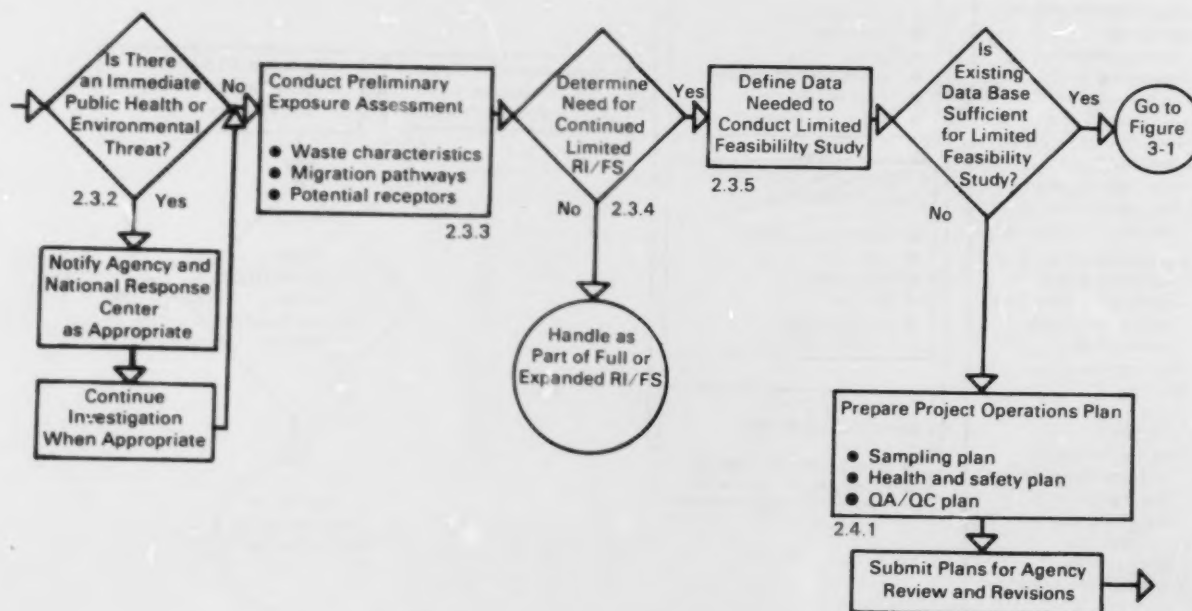
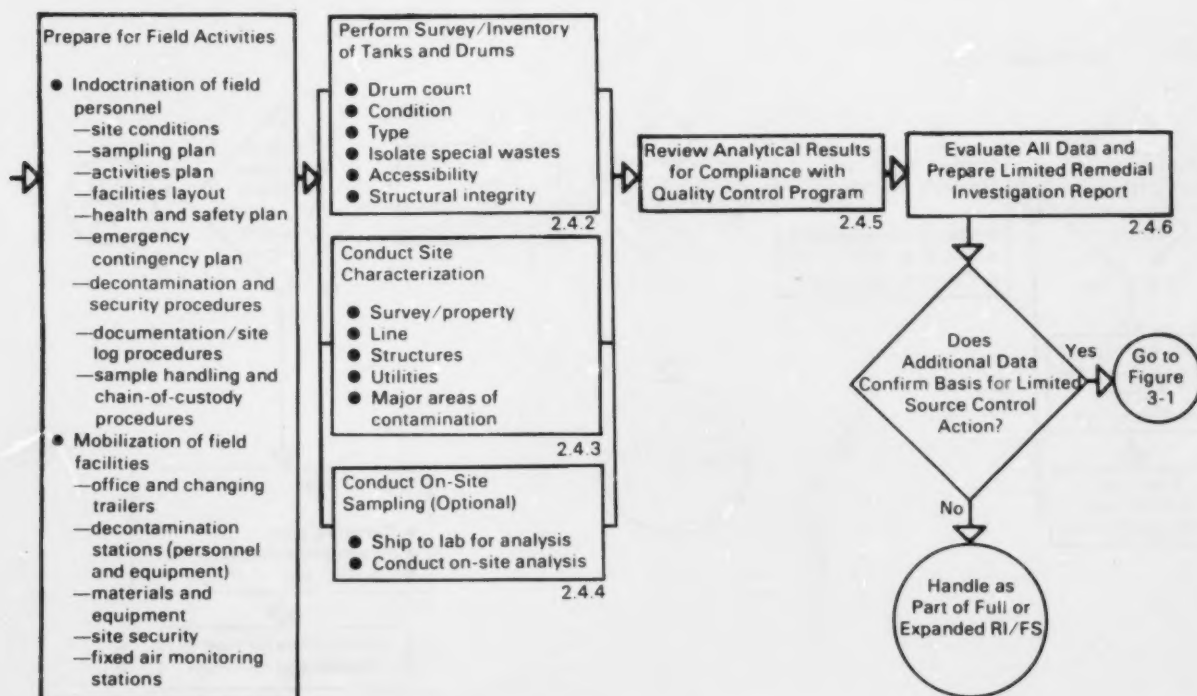


Figure 2-1. (continued)



- To provide a basis for initial site evaluation and identification of potential remedial alternatives (Section 2.2.4 and 2.3.1)
- To perform an assessment of current on-site hazards (Section 2.3.3)
- Identify and evaluate existing data base so that future field activities can be planned to fill data gaps (Section 2.3.6)
- To develop a data base for design of an ultimate remedial program (contract documents, plans and specifications) (Section 4)
- Provide data for evaluation of remedial alternatives (Section 3)

Techniques

There are many federal, state, and local agencies which may have pertinent information useful in conducting a limited RI/FS at a tank and drum site. Most of the available data may be general in nature but possibly useful in establishing a baseline. Other data sources that may be particularly useful in obtaining more specific information on the conditions of a site include:

- Site history, ownership, operation/disposal practices (past and present, from past owners, operators, and/or generators)
- Sensitive receptors in the vicinity of the site
- Initial planning documents, such as Remedial Action Master Plan if available
- Preliminary assessment/site inspection data
- Aerial photos of the site
- Hazard Ranking System (HRS) documentation

Many other agencies and potential data sources along with types of information that's generally available from these sources are reviewed in the Remedial Investigations Guidance Document (EPA, 1985).

Limitations

Effort should not be wasted on obtaining data that are not applicable to the scope of the project or obviously generic or duplicative in nature.

2.1.2 REVIEW AND EVALUATE AVAILABLE DATA

Purpose

The data should be evaluated and summarized in formats that are easy to review for individuals not involved in the collection process. By reviewing and evaluating the available data, an understanding of site conditions will be developed and evident data gaps will be identified. During this activity, the quality (i.e., accuracy and precision) of the data and its conformance with the quality assurance/quality control protocols under which it was collected, should be assessed.

Techniques

At this early stage it is important to focus on compiling as much information as possible on the quantity and types of wastes and the condition of tanks and drums found on site.

Whenever possible, available data should be summarized in graphical, tabular, or matrix formats. These formats are compact and allow for efficient presentation, comparison, and utilization of large amounts of data. A written summary is also valuable for conveying data trends and general conditions. All summaries, whether graphical, tabular or written, should identify both what is known -- conditions at the site -- and what is not known -- evident data gaps.

An important part of reviewing and evaluating the available data is an assessment of its reliability -- the extent to which the data represent site conditions. The dates of maps, drawings, and plans should be checked; sampling locations should be evaluated for representativeness. Analytical data should be checked against internal laboratory QA/QC criteria (blanks, duplicates, spike/recovery); and the methods of sample collection, preservation, handling, and sampler decontamination should be examined for potential irregularities. If more than one laboratory analyzed samples from the same area on site, the results should be assessed for consistency and variations in methodology should be identified.

Limitations

The data pool will be examined to see if the desired information is available. A balance must be maintained between the need to develop a detailed data base, the need to concentrate on data essential to solving environmental problems at the site, and the need to arrive at a solution expeditiously. The quality and accuracy of the data are principal concerns along with the relative timeliness of various data elements.

2.2 SITE FAMILIARIZATION AND PROJECT APPROACH

The goal of the second major component of the limited RI is to develop the approach (scope) to be followed in subsequent activities. This is accomplished through the preparation of preliminary maps and plans, and the identification of potential remedial technologies. The activities performed during this component are to:

- Prepare a preliminary base map of the site (Section 2.2.1)
- Prepare initial health and safety guidelines (Section 2.2.2)
- Prepare a community relations plan (Section 2.2.3)
- Identify potential remedial technologies (Section 2.2.4)

Identification of potential remedial technologies that are applicable to site conditions is a key step in the limited RI. By identifying these technologies early in the overall limited RI/FS process, subsequent data collection and analysis can be focused on the development and evaluation of realistic and practicable alternatives. Preparation of a base map, a community relations plan, and an initial health and safety plan will serve to better define site conditions and data needs. The health and safety guide will be prepared in conformance with Standard Operating Safety Guides (EPA, 1984).

2.2.1 PREPARE PRELIMINARY BASE MAP

Purpose

The purpose of this activity is to develop an accurate, detailed, up-to-date map of the site. The preliminary site map is needed to effectively plan the field activities of the initial site visit and is used to record many of the observations made during that visit. In most cases, the preliminary site map will be updated to provide a completed site base map which will provide an accurate representation of the drums and tanks on site as well as grossly contaminated soil areas, facilities on site and other key physical features to meet all limited RI/FS requirements.

Technique

The preliminary base map can be developed from existing site maps, aerial photos or a site topographic survey. The EPA Environmental Monitoring Systems Laboratory (EMSL) in Las Vegas, Nevada can provide a wider range of information on a site. EMSL will provide:

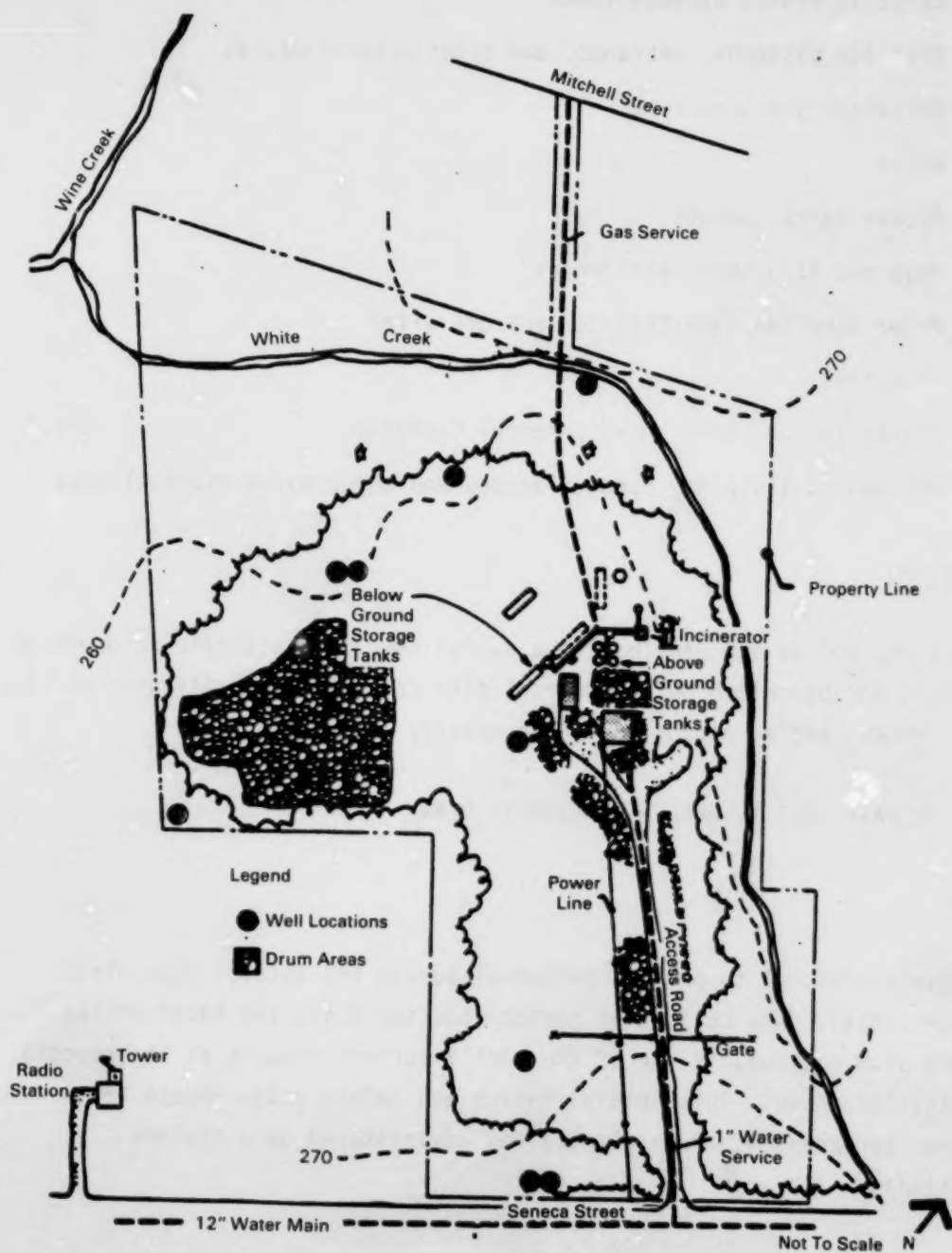
- Aerial photographs and analysis for a single date
- Aerial photographs and analysis over time either for the site itself or a larger area
- Topographic mapping at 1 foot to 5 foot intervals
- Orthophotographic mapping - a rectified photoimage with a topographic map superimposed

These services can be obtained through the regional EPA office.

A sample base map is included as Figure 2-2. Features shown on the site map should include:

- Property lines, used to identify boundaries for site access control and site security
- Drum number and location (noting if drums are stacked)

Figure 2-2. Existing conditions base map, example from an NPL site.



- Potential drum staging/decontamination areas
- Tank locations
- Existing piping between tanks
- Drainage patterns, wetlands, and other water features
- Buildings and structures
- Wells
- Access/egress points
- Adjacent structures/residences
- Prior sampling locations (on and off site)
- Topography
- Vegetation and other environmental features
- Stained soils, pits, ponds, lagoons and other waste disposal areas

Limitations

Old figures, photos and maps may be a useful source of historic information but should not be relied on for current site conditions. A fly-over of the site to obtain aerial photos may be necessary.

2.2.2 PREPARE INITIAL HEALTH AND SAFETY PLAN

Purpose

An adequate protocol to protect personnel during the initial site visit (Section 2.3.1), data collection period (Section 2.4), and later during tank and drum cleanup, is one of the most important aspects of the remedial investigation phase. This initial health and safety guide should be prepared, (or revised, if available) and administered by a trained professional.

Techniques

If an existing health and safety plan has been developed for prior site work, this plan may be adequate for the initial site visit. This document should be reviewed by a qualified professional using the existing site data base. If no plan exists, guidance must be developed based on the existing data. Appendix A is a set of site personnel protection and safety evaluation forms which can be used for this purpose. This guidance must include:

- An objective evaluation of the goals of the site visit and the remedial action
- An evaluation of site specific hazards, including airborne contaminants; potential radiological exposure; dermal hazards; hazards due to falls, electrical shock or other traumatic injury; hazards from heavy equipment operation, enclosed space entry, heat stress, etc.
- Medical monitoring of personnel going on-site
- Delineation of contaminated, decontaminated, and clean zones
- If tanks are to be surveyed, specific protocol must be included describing access procedures, how personnel are to open and check tanks, and how worker safety will be insured if tank structural integrity is uncertain.
- A description of site conditions including the number and condition of tanks/drums, and the nature of wastes on site
- Contingency plan for emergency action (e.g., include telephone numbers and locations of local hospitals, fire departments, and police etc.)
- Training required

The user is referred to the Occupational Safety and Health Guidance Manual for Superfund Activities (NIOSH, 1984) and Remedial Investigations Guidance Document (EPA, 1985) and Standard Operating Safety Guides (EPA, 1984) for additional information.

Limitations

If only limited data describing the potential hazard level on site are available, the health and safety guidance may be excessively conservative

or inadequate to protect workers. Any existing data or past health and safety plans should be field verified prior to adoption.

2.2.3 PREPARE COMMUNITY RELATIONS PLAN

Purpose

A community relations plan is a prerequisite for remedial actions at NPL sites because of their high public visibility and public interest.

Techniques

The purpose of a community relations plan is to keep the public aware of plans and activities related to the site and to receive input from the community regarding the site. This plan includes: a site description; history of community relations activities; discussion of key parties and their concerns; the site specific community relations objectives; communications methods; a staffing and budget plan; a site mailing list; and work schedule. Further guidance on these activities is provided in Community Relations in Superfund: A Handbook, Interim Version (EPA, 1983).

Limitations

Not applicable

2.2.4 IDENTIFY POTENTIAL REMEDIAL TECHNOLOGIES

Purpose

This activity plays an important role in the development of the remedial program and provides the basis to determine if existing data are adequate to support proceeding directly to a limited FS. A preliminary list of potentially applicable technologies is also prepared so that during the initial site characterization, any obvious limitations to a specific technology or alternative can be identified. While this step occurs in the RI phase, it is actually the initial activity of the limited feasibility

study phase. This overlap in phases helps to expedite the schedule, but more importantly improves the usefulness of data generated in the limited RI.

Techniques

The user should use best engineering judgment and working knowledge of remedial technologies to identify a range of potential remedial actions. Documents are currently available which describe remedial technologies for the cleanup of tank and drum sites (See Section 5.0).

If the project site is a "simple site" (i.e., a site containing less than 100 drums or a small volume of tankage, less than 10,000 gallons), one may be able to proceed directly to a limited FS (Section 3.0) and obtain other required data during the actual cleanup operation. Based on the small waste volume, the number of cost effective and feasible alternatives is limited and obtaining a detailed and extensive data base is not usually necessary.

Field activities during the limited RI should be directed towards obtaining data to aid in the evaluation of the range of remedial technologies that can be considered feasible at this point in the study.

Limitations

Limited data may make selective identification of potential remedial technologies difficult.

2.3 PERFORM INITIAL SITE CHARACTERIZATION

The initial site characterization is an important transitional activity which is centered around an initial site visit. The limited RI progresses from activities that are based upon existing data to activities and decision points which use information developed from initial field activities. The principal activities in initial site characterization include:

- Performing an initial site visit (Section 2.3.1)
- Determining if conditions could result in an immediate threat to human health and/or the environment (Section 2.3.2)
- Conducting a preliminary exposure assessment so the scope of the limited RI/FS can be evaluated (Section 2.3.3)
- Determining the need for continued limited activity based upon review of additional information (Section 2.3.4)
- Defining the data requirements for conducting the limited FS (Section 2.3.5)

2.3.1 CONDUCT INITIAL SITE VISIT

Purpose

The purpose of this activity is to:

- Verify existing data (e.g., estimate the number and location of tanks and condition of drums)
- Identify critical areas on-site (e.g., possible future drum handling areas)
- Identify wastes which require special care in handling due to high potential risks (e.g., cylinders, lab packs, containers/drums with various warning labels etc.)
- Gather additional data to support further site evaluation (e.g., number and type of drums, amount of waste in tanks, areas where spills have occurred)

Techniques

After all the preparatory activities described in Section 2.2 have been completed, the user is ready to enter the tank and drum site for the initial site visit. While on-site, the provisions of the initial site health and safety plan must be strictly observed. Furthermore, if anything unanticipated in the health and safety plan happens, discontinue on-site activities and re-evaluate the situation.

The potential hazards associated with volatilization of some organic compounds will be assessed utilizing a portable organic vapor analyzer (OVA), and/or commercially available portable photoionization GC. Indicator tube sampling can also be used to provide qualitative information or grab samples can be collected for later analysis by a laboratory, all of which can provide important input to the design of the site safety program. The sample team monitors ambient air for the specific compounds identified in preliminary information to determine whether an imminent health hazard exists. Typically, no waste sampling is performed during the initial site visit.

The following activities may be performed during the initial site visit:

- Estimate number and types of drum and tanks found on site. Note general condition of tanks and drums. Note any identification of types of wastes contained in tanks or drums.
- Identify
 - Site utilities, facilities and structures
 - Unusual waste (lab pack, cylinder)
 - Drainage
 - Spills, seeps, etc.
 - Divide site into zones to facilitate identification of drum/tanks and future remedial actions
- Make preliminary inventory of any waste surface impoundments and grossly (visually) contaminated soil areas
- Locate access, egress and security points
- Note evident environmental stress
- Perform air quality monitoring
- Interview local residents
- Photograph or videotape site features

Unique or special wastes are often found on tank and drum sites. During the site visit, note the presence of any of the following wastes:

- Laboratory packs (drums, cans or boxes containing laboratory wastes). These types of containers may hold biologically or genetically hazardous wastes. More commonly, however, lab packs hold small containers of often incompatible materials.
- Radioactive materials
- Gas cylinders
- Explosives/shock sensitive materials
- Highly reactive wastes

A much higher level of risk is associated with the disturbance or handling of these types of wastes. If any of these wastes are observed on-site, assistance from trained personnel who are experienced in dealing with these types of wastes should be obtained before proceeding further.

Limitations

During the initial site visit, little or no sampling is performed and only preliminary on-site activities are performed. Critical information such as the location number and size of tanks and drums can be obtained. Tanks (and possibly a limited number of drums) can be identified by spray painting identifier numbers on each drum and tank. This effort could assist in any future sampling activities. Unless absolutely unavoidable, the movement or staging of drums at this point is not recommended. Depending on site specific features, (e.g., piled and unlabeled drums) it may be difficult to identify special wastes.

2.3.2 DETERMINE IF AN IMMEDIATE THREAT EXISTS

Purpose

The primary purpose of this activity is to determine if an immediate threat to human health or the environment exists. The most common threat would be the release of hazardous wastes due to rupture and/or explosion of tanks or drums.

Technique

The following physical conditions justify special and immediate attention:

- The absence of fencing or other measures to prevent direct contact between the public and hazardous materials in or around the tanks and drums
- The presence of flammable or explosive materials in situations making fire or explosion possible or probable
- Severely degraded tanks or drums that could result in sudden and/or widespread releases of hazardous materials
- Air releases above acceptable levels as measured by direct reading instruments or other air quality monitoring devices

The presence of one or more of these conditions does not necessarily mean there is a significant immediate threat to human health or environment. Other factors should be considered such as: types of waste materials in the tanks or drums; location and exposure routes to sensitive/human receptors; and existing topographic and physical site features near the site.

If an immediate threat is observed during the initial site visit, after all factors have been considered, the agency responsible for site activities and possibly the National Response Center [Telephone (800) 424-8802] should be contacted.

An example matrix which may be useful in evaluating if an immediate hazard exists on-site has been included as Table 2-1. The effectiveness of this type of format will depend on the quantity and quality of available data.

Limitations

If uncertain of the nature and significance of the threat, contact the agency responsible for site activities and evaluate the situation with them before contacting the National Response Center. The focus at this point is

TABLE 2-1

EXAMPLE OF A SIMPLE PROCEDURE FOR
EVALUATION OF SHORT-TERM HAZARDS AT TANK AND DRUM SITE

Location	Type	Inherent Hazards (A)	Quantities Present (B)	Likelihood Of Contact (C)	Characteristics Of Concern (D)	Threat/Exposure Potential (E)
Zone A	Liquid Drummed Waste	High	High	High	Acute Toxicity Highly Reactive	Very High
Zone C	Liquid Tank Waste	High	High	High	Acute Toxicity Flammable	High
Zone A & B	Solid Drummed Waste	Low	Low	Low	Toxic Explosive	Moderate
Zone C & D	Solid Tank Waste	Low	Low	Low	Toxic	Low

- A. From toxicity data and information on presence of caustic and flammable wastes (Rated low to high)
- B. From data on concentrations in wastes and environmental media (Rated low to high)
- C. From information on human activity at or near site and review of plausible pathways of exposure (Rated from low to high)
- D. Define characteristics of public health concern (toxicity, reactivity, ignitability, etc.)
- E. Weighing information in previous columns (fire, explosion, direct contact, and acute toxicity)

defining and reducing very eminent and obviously dangerous conditions. Waste material is not generally removed and typical actions could include fencing and other security precautions.

2.3.3 CONDUCT PRELIMINARY EXPOSURE ASSESSMENT

Purpose

The level of hazard posed by the site is assessed for each of the identified receptors, and the need for further action is determined. This assessment will be used and further evaluated during the limited FS to determine if a no action alternative is appropriate.

Techniques

The following steps may be used to perform this preliminary assessment:

- Identify probable waste sources and types from labels or site history. Information available on the type of waste in tanks or drums and the condition of the waste containers should be noted. The example matrix presented as Table 2-2 may be used for this purpose. Relevant information may have been collected as part of Task 2.3.1 (Initial Site Visit). However, no detailed tank or drum inventories have been conducted, nor have tank or drum contents been sampled. Therefore, identifying specific wastes present may not be possible.
- Identify the pathways of contaminant migration for each waste source (surface water, ground water, air transport, ditches, etc.)
- Identify receptors of the migrating contamination (nearby residents, wells, wetlands, endangered species, etc.)
- Determine if a remedial action is necessary to mitigate the threat to human health or the environment.

Evaluation of the actual or potential threat may include a qualitative evaluation of conditions such as the likelihood of migration, amount of contaminant migration, and time frame of the exposure. In most cases, drums and tanks containing concentrated waste without proper maintenance and controls can be presumed to present an actual or potential threat to the public health or environment.

Limitations

Data available at this stage of the investigation may allow only a very cursory assessment of exposure and threats to public health and the environment.

2.3.4 DETERMINE NEED FOR CONTINUED LIMITED ACTIVITY

Purpose

The decision to conduct a limited RI/FS for tanks and drums should be re-evaluated in light of the detailed review of data and the initial site visit. While the basic objectives of a limited RI/FS may still be valid, it may be more appropriate to expand the scope to include other wastes found on site (e.g., in lagoons or within the soil). The cost-effectiveness of a focused fast-track tank and drum project must be compared with the value of integrating the tank and drum portion into the overall site RI/FS.

Techniques

Criteria for making a decision on whether to continue a limited RI/FS for tanks and drums or to expand the scope to include the entire site will obviously vary depending upon site-specific conditions. Some areas which should be focused upon are summarized below:

- Public Health and Environmental Risk - Does fast-track handling of drummed and tanked waste significantly reduce potential public health and environmental risk?
- Cost-Effectiveness - Based upon new information, is there a potential for implementing a remedial program for the entire site on a more cost-effective basis than a limited approach?
- Schedule - Does new information show that the schedule for implementing a limited remedial action would not differ much from that of a larger scale action?

Limitations

In deciding whether to expand the scope of the limited RI, the types of remedial technologies involved with handling the different contaminated areas on-site must be considered. In most cases, the remedial technologies for disposal of buried wastes, waste piles and waste spills (contaminated soil and water) are different than those for tank and drum wastes. Where these different types of wastes are present, the combination of remedial technologies may be difficult and may not be cost effective. However, wastes contained in surface impoundments may be similar or related to wastes in tanks and drums on the same site. Previous operators of the site may have used the surface impoundments to hold certain waste residues removed from the tanks/drums, or may have used impoundments as an intermediate step in a waste reclamation process. In cases such as these, it may prove cost-effective to combine remedial technologies for the similar types of wastes.

If the preliminary assessment indicates that migration and/or significant exposure from hazardous materials from tanks and drums cannot be reasonably expected in the short term, the limited RI should still continue since the tanks and drums are still in an uncontrolled environment with the potential to cause harm or damage.

In very unique circumstances, it may be possible to discontinue the limited RI/FS. For example, all drums may be empty, crushed, and/or filled with contaminated soil. With this situation the drums would no longer pose as immediate a threat and could be addressed in the full RI/FS along with contaminated soil, ground water, etc.

2.3.5 DEFINE DATA NEEDED TO CONDUCT LIMITED FEASIBILITY STUDY

Purpose

The data needed to evaluate the feasibility of potential remedial technologies (identified previously) are compared with the data collected up to this point in the limited RI. If the limited RI data base is

sufficient to conduct the feasibility study, the final component of the limited RI can be omitted and the limited FS initiated directly. If there are deficiencies in the data base which would restrict the performance of the limited FS then additional data will be required.

Techniques

The types of data needed to evaluate remedial technologies are often described in existing reference documents. A summary of data needs can be prepared for techniques applicable to tank and drum remedial actions. Table 2-2 has been prepared and presents a list of data needs for evaluation of on-site disposal and/or treatment of tank and drum wastes. This type of information would be useful for many components of the limited FS (e.g., developing costs and design evaluation criteria). If treatment options are being considered, the applicability of various technologies to the site-specific waste characteristics should be reviewed.

Comparison of the data needs with the existing data base will identify any data gaps. The data gaps for each of the technologies should be consolidated into a master list and then evaluated for significance of the missing data. Although certain data may not be directly available, it is often possible to estimate certain parameters or quantities without compromising the validity of a feasibility evaluation. However, current EPA policy is that data must be adequate enough to prepare a +50/-30 percent cost estimate.

Limitations

Not applicable.

2.4 CONDUCT DETAILED FIELD INVESTIGATION

Once potential remedial technologies have been developed and data gaps defined, a limited field investigation is performed to gather the required data to evaluate the technologies. The following steps can be followed for the final stage of the limited RI.

TABLE 2-2

EXAMPLES OF DATA NEEDS FOR EVALUATION
OF POTENTIAL REMEDIAL ACTIVITIES

- Flood prone (Is the site located in the 100-year floodplain?)
- Seismic (Is the site located within 200 feet of a fault which has had displacement in recent geologic history?)
- Groundwater vulnerability (Does groundwater under site have a rapid rate of travel, i.e. greater than 100 feet per 100 years?)
- Is the site in a wetland?
- Is the site in area with karst, subsidence or landslide activity?
- Is the depth to the seasonally high groundwater elevation beneath the site relatively shallow (i.e., less than 10 feet)?
- Is the groundwater beneath the site used for individual or municipal water supply?
- Is the site topography relatively steep (i.e., greater than 30 percent)?
- Is the site located in the vicinity of a surface water body or a groundwater recharge area?
- Have springs or seeps been identified in the area of the site?
- Has underground mining previously been performed in the vicinity of the site?
- Is the site located in an area with weak and unstable soils?
- Is the hydraulic conductivity of the bedrock beneath the site relatively high (e.g., as would be expected within a sandstone or fractured zone)?
- Is the site located in close proximity to a residence, school, hospital, commercial area, or other sensitive receptors?
- Is an adequate buffer zone present around the site?
- Is the site located in close proximity to a public water supply (e.g., reservoirs, watersheds or supply lines)?
- Are there unique and protected land uses adjacent to the site, e.g. parks, historic sites, etc.

2.4.1 PREPARE PROJECT OPERATIONS PLANS

Purpose

Prior to beginning on-site elements of the limited RI, certain planning and preparation must be completed. The development of project operations plans will assist the user in initiating the limited RI, performing the limited RI in a safe and effective manner, and in being prepared for emergency situations should they arise.

Techniques and Limitations

The major components of a project operations plan include a sampling plan and a health and safety plan. In addition, a quality assurance/quality control (QA/QC) plan may be included as part of the project operations plan or as a separate document. Normally a quality assurance plan is formulated outside of the project operations plan and quality control is addressed within the project operations plan.

2.4.1.1 Sampling Plan. A sampling plan is developed to describe what data will be obtained, what sampling will be performed, and how these tasks will be completed. The plan is then reviewed by all involved parties to ensure that data requirements will be met and that the data will be collected in a proper and effective manner.

It is important to define specific objectives of the sampling program in the plan. How data will be used in the limited FS should be indicated. Also, the waste categories will be clearly defined with a description of the relationship of these categories to the limited FS and project implementation activities.

Many guidance documents exist for preparing a sampling plan (see Section 5), as well as sampling plans used for completed projects. A typical plan for a tank and drum site would address the following topics:

- Goals of sampling effort

- Use of sampling data (to select treatment or disposal options)
- Types of surveys to be performed (detailed drum inventory, detailed tank survey, air monitoring, tank wall thickness and integrity, etc.)
- Number and type of samples (primarily wastes from tanks and drums) and constituents for analysis
- Sample analyses/compatibility testing: organic/inorganic, reactivity, flash point, halogen content, PCB, cyanide, sulfide, etc.
- Methodology describing sampling procedures

The characterization of types of wastes on-site is used to prepare design reports, feasibility studies, cost estimates for cleanup, and contract documents. Drum sampling prior to remedial action is generally limited to a random sampling of the above-ground drums; tank sampling may be more complete. The number of drums and tanks to be sampled is dependent upon the total number on-site, costs, schedule, and physical condition of the drums or tanks.

There are basically three strategies for drum sampling:

1. Sample all drums (probably requires staging)
2. Random sample with little or no staging
3. No sampling

The first strategy is the most thorough and also the most costly. It is usually not practical for a limited RI/FS. The second strategy, as indicated, is the most practical and has been the practice/policy at several drum sites. Costs are kept fairly low and a limited data base is provided. The random sampling approach does not provide a complete data base which would be available from a full drum sampling program. However, a random sampling program does provide a useful data base without the costs and potential problems of a full sampling program. The staging and equipment requirements for a full sampling program can extend the duration of the limited RI and can be costly. No sampling avoids cost and schedule issues but provides no direct analytical data on the drums.

Some of the key issues to consider when weighing the potential advantages and disadvantages of a particular drum sampling program are summarized below:

1. A full sampling program will require drum staging or at least considerable drum handling during the remedial investigation activities. This will require special equipment and contingency planning, including a complete health and safety plan and equipment plus full decontamination facilities. These would not be necessary with a more limited sampling program.
2. It would be very expensive to conduct a full sampling program of drums. For example, just the decontamination facilities alone can run \$10,000 to \$30,000 for equipment and personnel and \$0.50 to \$1.00 per gallon for disposal of the wash water. Added to this would be the obvious cost of sampling and analytical activities.
3. Before a cleanup contractor can remove drummed wastes off-site it may be necessary to sample each drum for the following reasons:
 - determine compatibility for bulking
 - provide information for preparing manifest for shipment in order to meet EPA and DOT requirements [see 40 CFR 262.11(c)]
 - provide additional information (if required) for the TSD facility receiving the waste
 - ensure overall safety in handling, packaging and transporting wastes

Since remedial contractors must sample all drums for manifesting prior to transportation and disposal, it is usually cost-effective to postpone a comprehensive drum sampling until the remedial contractor is ready to initiate on-site activities. As a result random sampling is performed to provide a data base for the limited FS and primarily for preparation of contract documents.

4. Random sampling, while providing a limited data base can be a useful alternative to full sampling. The data can be used to expand the general knowledge of the site, but more importantly, it has a useful function in preparing competitive bid documents.
5. No sampling of drums is obviously the least expensive way to conduct a limited RI. However, without even a random sampling data base, it becomes difficult to prepare a competitive bid package and ultimately contract documents. Additionally, further planning and design activities have to progress with little or no information on the characteristics of drum wastes.

A drum sampling program should be limited to approximately 5-10 percent of the containers. The reasoning is that on an abandoned drum site, the containers probably have accumulated at the site over a period of years, possibly from many different sources. Drums may be full of spent cleaning solutions containing unknown material or manufacturing by-products. Additionally, many of these sites functioned as recycling centers with the more homogeneous or quality material being sold as a product. If a manufacturer had a by-product of any worth or volume, it probably would have been recycled directly and, due to transportation costs, would not be shipped in individual drums. Also, because of the wide range in the types of materials that may have been accepted at a site, random sampling would not be statistically significant, but would only indicate the waste category of the container sampled. Random sampling could, however, help delineate between a site with a wide range of heterogeneous waste and one with wastes of a homogeneous nature. This may provide evidence identifying a site where waste was produced on site and the drums were used for storage.

Random sampling can also provide some insight into the types of waste categories that might be encountered at the site. Again, statistically these data will have limited value in providing an accurate projection of all the waste types or quantities, but this data base can be combined with the drum inventory, presented in Section 2.4.2, to develop reasonable estimates. This information is particularly important for preparing contract documents and may be useful for the limited FS.

A "stratified" random sampling technique for drums may be applicable for many sites. The approach differs somewhat from a pure random sample program in that selection criteria are developed for groups of drums rather than treating the entire site as one group. For example, a stratified random sample approach may group drums found on-site into the following categories:

- Drums of similar color and condition with labeling suggesting one source/generator

- Drums with polyliners suggesting similar types of wastes
- Areas of drums which have been obviously separated from other drums
- Miscellaneous drums not falling into other defined groups

A random sampling procedure would be developed for each group. A "stratified" random sampling procedure developed for the different groups could result in a data base more representative than a pure random sample selection which considers all drums on-site as a single group. The results of a stratified random sampling program may suggest that wastes found in similar drums or in one area are similar or dissimilar.

Random sampling of drums at two NPL sites involved 6 and 20-25 percent of the drums, respectively. A considerable amount of detail was available for one site and it was possible to determine the number of specific types of drums and containers at various locations at the site. This information was valuable to potential contractors in determining equipment needs and drum removal costs. Also, using the data derived from the random sampling effort, it was possible to develop a gross categorization of waste types found at the site (Table 2-3). At the other site a similar approach resulted in a characterization that provided an accurate engineer's cost estimate for total cleanup.

Tank sampling has shown to be an advantage when addressing waste categories and evaluating remedial action alternatives. This is primarily due to the relative cost-effectiveness of a sample taken from a 20,000 gallon tank as compared to the same sample from a 55 gallon drum. More importantly the data on bulk quantities of waste can be very useful in the limited FS along with helping in the preparation of contract documents.

In tank sampling, two key points should be made. The first is that tanks, more so than drums, can maintain an internal explosive atmosphere, and as such require special tools (cold cutting). Therefore, under an RI level of effort, only tanks with access ports should be sampled. Secondly, tanks, because of relative volume and quiescent condition, tend to stratify. It

TABLE 2-3

CATEGORIZATION OF WASTE TYPES AT AN NPL
SITE BASED ON RANDOM SAMPLING* OF DRUMS

Solids	19%
Acids	16%
Non-chlorinated Solvents	14%
Resins	9%
Aqueous Waste	7%
Alkali Waste	7%
Cyanide Waste	6%
Waste Oil	6%
Paint Waste	5%
Sludges	4%
Chlorinated Solvents	2%
Glycols	2%
Empty	1%
PCB Oil	1%

* Based on a random sampling of 20 to 25 percent of drums.

is not uncommon for as many as three phases (oil, liquid and sludge) to be discovered. A sample should be collected from each phase. The level of sample analysis for either tanks or drums is generally limited to that which is necessary to determine compatibility and that required for disposal. Compatibility analysis is usually restricted to the tank waste during the RI study but will be performed on all of the tank and drum waste by the contractor as part of the consolidation and bulking protocol. Appendix B includes an example of a drum and tank sampling protocol for waste compatibility, and is followed by Appendix C, which presents the protocol for bulking and consolidation of identified compatible waste groups. Depending on the structure of any random drum sampling, a compatibility analysis could be included as part of the drum sampling program. The main categories of compatibility analysis include the following:

- Ignitability (flash point)
- Radioactivity
- Determination of oxidizing or reducing agent
- Reactivity
- Density
- Concentration of organic halides
- PCBs
- pH
- Cyanides
- Sulfides

In order to further categorize wastes in terms useful for evaluating potential treatment and/or disposal technologies, additional waste characterization is needed. While compatibility characterization is a useful first step more specific criteria are required for waste categorization. Waste categories useful in evaluating various treatment and disposal technologies are listed in Table 2-4.

TABLE 2-4

WASTE TREATMENT DISPOSAL CATEGORIES

AQUEOUS WASTES

- Acid: pH < 2.0
- Base: pH > 12.0
- Base with sulfur
- Base with Cyanide

ORGANIC LIQUIDS

- High halogen Content (> 2%)
- Low halogen Content ($\leq$ 2%)
- PCB Contaminated Liquid (50-500 ppm)
- PCB Contaminated Liquid (> 500 ppm)

CONTAMINATED WATER

- 2 < pH < 12
- Inorganic
- Organic
- PCB Contaminated Liquid (< 50 ppm)

SLUDGES

- PCB Contaminated Classified as liquid (50-500 ppm and > 500 ppm)

SOLIDS

- PCB Contaminated (> 50 ppm)

SLUDGE/SOLIDS

- Organic Low Halogen
- Organic High Halogen
- Inorganic
- PCB Contaminated (< 50 ppm)
- Flashpoint (< 70 °F)
- Flashpoint (70 - 140 °F)
- Flashpoint (> 140 °F)

SPECIAL WASTES

- Water Reactive
- Air Reactive
- Radioactive
- Strong Oxidizer
- Strong Reducer
- Lab Packs
- Explosives

References have been made to Appendices B and C, example of a "Drum Handling, Drum Sampling, Special Waste Handling, and Tank Sampling Protocol," and example of a "Bulking and Consolidation Protocol." Appendix B presents compatibility testing procedures which must precede the actual bulking and consolidation procedures included in Appendix C. The material presented in these appendices can be used during planning activities for sampling, during the actual execution of sampling activities, or during project implementation. The protocols should be tailored to the specific needs of the user. For example, random sampling for drums could include compatibility testing if a "stratified" approach were used. However, the use of a more general random selection approach may limit the usefulness of a compatibility analysis. Compatibility analysis will always be required before bulking or consolidating wastes.

In general, field analyses are typically less costly to perform than full laboratory analysis. Sample shipping and chain-of-custody is minimized for the majority of samples.

The user should be aware that any field analysis of samples will not produce the litigation-quality documentation available through a laboratory. Instead, field analysis can be used to develop information to proceed with the project while a small percentage (e.g., 25 percent) of the samples are sent to a laboratory for analysis and verification. Additionally, field screening techniques are of limited value in complex samples (e.g., oily sludges) and are not available for all contaminants. For example, few field instruments measure inorganics. Additionally, because of the concentrated nature of these samples, a laboratory equipped to handle such high-hazard samples (such as EPA's hazard laboratory at NEIC) may be required.

2.4.1.2 Health and Safety Plan. A health and safety plan is developed to establish the procedures that will be followed during the execution of the detailed field investigation. This plan is developed from earlier health and safety protocols (See Section 2.2.2) and information assembled from activities such as the initial site visit (Section 2.3.1). EPA's guidance on health and safety can be found in Standard Operating Safety Guides (EPA, 1984).

To confirm the basis for the site worker respiratory protection protocol contained in the health and safety plan, both on- and off-site air quality monitoring should be initiated at the onset of the project mobilization and maintained during on-site activities. Additionally, due to the nature of waste materials commonly found in tanks and drums and their ability to rapidly degrade ambient air quality, it is important to continue air monitoring both on- and off-site during the limited RI so that potential impacts from handling wastes can be evaluated.

A specific air monitoring program must be established for each site based on the nature of the wastes present and site conditions. Sampling may be performed for organics (volatile compounds), inorganics (cyanide gas), or airborne particulate (asbestos). Methods currently used to monitor air quality at tank and drum sites include:

- Direct reading methods
 - Organic Vapor Analyzer (OVA)
 - Photoionization detector
 - Infrared gas monitors
 - Explosive gas indicator
- Delayed quantification techniques
 - Collection of samples using air sampling pump and sorbent charcoal, glass filters, or other media.

Other components of the health and safety plan include training program (for drum and tank entry and sampling), contingency plan (for drum breach, drum explosion, etc.) and guidance on area and access restrictions.

Table 2-5 has been prepared as an example to develop procedures for safely sampling tanks and drums. The operations presented in this table are general in nature and must be modified or supplemented based on actual site conditions. Because of the hazards inherent in these operations, safety plans should be extremely conservative.

TABLE 2-5

EXAMPLE OF PROCEDURES FOR TANK AND DRUM SAMPLING: SAFETY ASPECTS

Protective Equipment: Hard hat, safety shoes, safety glasses, rubber gloves, face shield, protective suit, respirator*, lifeline (for tank sampling).

Potential Hazards: Fire and explosion, inhalation of toxic or flammable vapors, skin contact with waste.

OperationsWork Procedures

- | | |
|---------------------------------|---|
| 1. Inspect tank or drum | Examine tank or drum for signs of pressure buildup, shock, sensitivity, etc. |
| 2. Monitor vapor concentrations | Collect grab samples to determine concentrations of organic compounds. |
| 3. Ground tank or drum | Clean surface area of tank and attach ground. |
| 4. Minimize exposure | Position employees upwind from tank hatch or drum. |
| 5. Remove drum cap | Slowly remove cap or bung, and allow vapor to escape. For drums, use of a remote or non-sparking bung removal apparatus should be considered. |
| 6. Measure vapor | Collect grab samples to evaluate concentration and flammability of vapor and gases. If vapors are hazardous wait 5 minutes and retest. |
| 7. Insert sampler | For Tanks: Lower sampler (Bacon Bomb-ASTM D-720) to collect samples of: <ul style="list-style-type: none"> a. upper sample - middle - upper third b. middle sample - middle of tank |

*In some cases, the use of self-contained breathing apparatus is required when the contents of a tank are unknown or suspected to be a high hazard. Under no circumstances should the user enter the tank. This table does not address tank entry procedures. See Appendix B for further details.

TABLE 2-5 (Continued)

EXAMPLE OF PROCEDURES FOR TANK AND DRUM SAMPLING: SAFETY ASPECTS

<u>Operations</u>	<u>Work Procedures</u>
	c. lower sample - near bottom
	For Drums: Insert glass sampling thief into bung hole until solid material is encountered.
8. Collect sample	For Tanks: Pull out bottle stopper with sharp jerk of sample line and allow bottle to fill.
	For Drums: Place finger over end of thief and remove from drum.
9. Retrieve sample	For Tanks: Raise sampler, wipe off surface of sampler and place cloth in disposable plastic bag. Tag sample and record data on forms for drums:
	Place bottom of thief in glass container and release thumb for thief. Repeat steps 8 and 9 until sufficient sample is collected (200 ml).
10. For Tanks: Cover tank	Carefully close tank cover.
11. For Drums: Dispose of thief	Insert thief in bung hole and replace bung. NOTE: if wastes are to be transferred, a screen must be placed on pump intake to prevent damage by glass pieces.
12. Monitor vapor concentrations	Collect grab sample to evaluate concentration of vapor post-closure.

*In some cases, the use of self-contained breathing apparatus is required when the contents of a tank are unknown or suspected to be a high hazard. Under no circumstances should the user enter the tank. This table does not address tank entry procedures. See Appendix B for further details.

2.4.1.3 Quality Assurance/Quality Control Plan. A quality assurance plan is an assemblage of management policies, objectives, principles, and general procedures to be followed in producing environmental monitoring data of known and acceptable quality. Quality control refers to the routine activities and checks, such as calibration and duplicate analysis, conducted under the quality assurance program.

EPA's guidance on preparing quality assurance plans is found in Guidelines and Specifications for Preparing Quality Assurance Project Plans, (EPA, 1983). The sixteen components of a quality assurance plan according to the EPA guidance are:

1. Title page with provision for approval signatures
2. Table of contents
3. Project description
4. Project organization and responsibility
5. QA objectives for measurement data in terms of precision, accuracy, completeness, representativeness, and compatibility
6. Sample procedures
7. Sample custody
8. Calibration procedures and frequency
9. Analytical procedures
10. Data reduction, validation and reporting
11. Internal quality control checks
12. Performance and system audits
13. Preventive maintenance
14. Specific routine procedures to assess data precision, accuracy and completeness
15. Corrective action
16. Quality assurance reports to management

Some of these components of the quality assurance plans are actually quality control procedures. For example, the "Calibration Procedures and Frequency" section of the QA plan may merely reference the applicable standard operating procedure (quality control) found in the sampling plan or health and safety plan.

2.4.2 PERFORM TANK AND DRUM SURVEY/INVENTORY

Purpose

This task will provide information describing the number, type, and condition of drums, the type of wastes in the drums (liquid, sludge, solid, etc.), and the source of the drums. Additionally, important information on tanks can be obtained by a survey from the air or ground. This information will play a major part in the selection and development of the remedial program, evaluation of disposal technologies, and development of bid documents. Preliminary information was developed during the initial site visit (e.g., estimated number of drums). This physical survey is more detailed and comprehensive than the initial site visit.

Techniques

A drum survey is an actual physical inventory and evaluation of drum wastes. It is different from random sampling in that no detailed chemical analyses are performed. The drum survey must be tailored to the size and nature of the site. Two major techniques, aerial survey and ground survey, are typically used to perform this task. There are advantages and disadvantages associated with each of these methods. Usually an aerial survey will supplement a ground survey. The characteristics of these two types of surveys are summarized in Table 2-6. Examples of techniques for examining, handling, staging, (if applicable) and labeling drums are contained in the references in Section 5.0. It should be noted that depending on the number of drums and access to them, it may not be possible to inspect every drum. Tasks typically performed include:

TABLE 2-6

ASPECTS OF AERIAL AND GROUND DRUM SURVEYS

ASPECT	METHOD	
	AERIAL	GROUND
Drum Count Possible	YES	YES
Identify Drum Type	PARTIAL	MOST OR ALL DRUMS
Identify Overpacks and Polypaks	PARTIAL	YES
Label Identification	PARTIAL	YES (IF PRESENT)
Evaluate Drum Integrity	DIFFICULT	POSSIBLE
Note Presence of Pails, Buckets, Boxes, etc.	YES	YES
Note If Drums Have Bulged	DIFFICULT	YES
Number Drums	NO	YES
Cost of Survey	LOW	MODERATE TO HIGH

- Drum count and aerial classification (number of drums and location on site)
- Note drum type (bung or lid, steel or plastic)
- Presence of polypacks and overpacks (If these types of drums are present on site, the contractor should realize that the drums probably contain wastes which are capable of degrading steel containers or contain drums of low structural integrity.)
- Label identification (An attempt should be made to record all labeling on drums to assist in the identification of the drum contents. If proper manifesting occurred during site operation, this effort may produce very good results. However, because waste products are often placed in used containers, the labels should not be the sole basis for classifying the drum wastes.)
- Noting drum integrity and evidence of leakage (Drum integrity can be evaluated by carefully sounding the drums, examining them for degradation, and other non-intrusive techniques.)
- Note if drum ends bulge
- Numbering drums (for future identification)

An example drum inventory form that could be prepared prior to initiation of the survey is presented in Table 2-7, although a form allowing more information on drum identification and condition may be of value. A computer-compatible form may be useful to allow easy data entry. This is particularly true for sites with a large number of drums. Information could be derived from a detailed drum inventory on probable waste categories based on the type of drum. These are presented as follows:

- Empty - drums with less than 1 inch of residual solids in the bottom can be crushed and disposed of as an empty drum (see discussion below)
- Lab packs - these are 55 gallon ring top drums which contain numerous small containers of unknown laboratory wastes.
- Overpack - these are 80-85 gallon oversized drums used to hold a standard (damaged) drum
- Polyliner - these are generally 55 gallon drums which contain a plastic bladder usually containing highly caustic (acid or alkaline) wastes
- Polydrums - these are fiber polylined disposable drums which contain caustics.

TABLE 2-7
EXAMPLE DRUM INVENTORY FORM

LOCATION	EMPTY	LAB PACKS (ACTUALLY SEEN)	OVER- PACKS	POLY/ LINER	POLY- /DRUM	BUNG TOP	RING TOP	OTHER CONTAINER	MISCEL- LANEOUS	TOTAL
Zone A	75	2	25	15	15	50	40	10 ^a	250 ^b	482
Zone B	3	0	40	0	0	140	40	0		223
Zone C	12	1	0	6	7	15	12	0	200 ^b	253
Bldg #1	0	10	0	50	50	80	0	15 ^c		205
TOTAL	90	13	65	71	72	285	92	25	450	1163

NOTES:

- a. Unlabeled five gallon containers
- b. Piled drums, access restricted, quantity is estimate
- c. Unlabeled one gallon containers

- Bung top - this is a standard 55 gallon drum with the typical 2-3 inch screen hole on the top, used to carry liquids such as spent solvent waste
- Ring top - these are the standard 55 gallon drums that are open top usually containing solids or resins

Under certain conditions, empty drums may be disposed of at a sanitary landfill. However, possible restrictions on the disposal of materials found at NPL sites should be reviewed with appropriate agencies. Additional information on the definition of empty drums can be found in 40 CFR 261.7. Also, limitations on the reuse of drums can be found in 40 CFR 173.28.

Staging of drums (the process of moving drums from various locations to one area in a logical and systematic manner) is not recommended because of high costs and hazards associated with this activity. Staging should be considered only under the following conditions:

- Very obvious hazards if left unstaged (incompatible labeled drums next to each other)
- Drums are leaking
- There are severe access restrictions
- Drums can easily be grouped by type (a possible advantage during the development of bid documents)

If staging is required, a staging plan should be developed and reviewed by all involved parties. In planning staging areas, the size and goals of the operation, accessibility of drums in their original locations and the hazards associated with the drums must be considered. There may be up to five staging areas that can be used:

- Initial staging area - organize drums and store prior to sampling
- Opening area
- Sampling area
- Holding area - temporary storage area prior to characterization of contents

- Bulking area - should be located as near to the site's exit as possible

The number of areas used and movement of drums should be minimized. Drums are generally staged in rows which allow ease of access and handling.

The major elements of a tank survey include determination of:

- Number of tanks
- Tank location
- Tank volume and size
- Structural integrity (using visual examination or methods such as x-ray and ultrasound)
- Accessibility (Is there sufficient ground space and overhead clearance to allow use of articulated boom crane? Can personnel climb into tanks?)
- Volume of waste in tanks (methods include sounding, probing, and visual inspection)
- Nature of waste in tanks
- Existing mechanical plant (pumps, compressors, pipes), piping, and other connections between tanks.

Limitations

The drum survey is designed to gather as much information as possible without actual analytical activities. Drum sampling may or may not be performed during the limited RI. Drum staging should be avoided except for very unique or special occasions.

Due to the questionable integrity of certain tanks on-site, only limited data may be obtained from these tanks. Additionally, special equipment and tools may be required to open and/or sample these and other tanks. This could include the use of an articulated boom crane to provide access to the tank, use of remote opening devices, and use of self-contained breathing apparatus (SCBAs) by personnel.

2.4.3 CONDUCT SITE CHARACTERIZATION

Purpose

Information describing site conditions other than tanks and drums are required for remedial alternative evaluation and planning. These data are obtained as part of site characterization activities.

Techniques

Typical site characterization tasks include:

- Property line, topographic, stadia and aerial surveys (to define site limits, access, drainage, relief, and layout.)
- Confirmation of site utilities and facilities (to determine how existing facilities will affect work, what utilities are needed, etc.)
- Identification of areas of contamination (may be completed by visual inspection, sampling, geophysical survey, infrared photography, etc.)
- Description of subsurface conditions. (Existing boring logs, well reports, etc. may be available. If these are not available, information is obtained through a boring and soil testing program, which is not usually a part of a limited RI.)

Limitations

This information may have been collected during the initial site visit so that no further site characterization is required.

2.4.4 CONDUCT SAMPLING PROGRAM

Purpose

This activity executes the sampling program developed as a result of those activities described in Section 2.4 Prepare Project Operations Plans. As previously discussed, all tanks should be sampled, whereas random sampling drums may be the preferred approach.

Sampling of drums and tanks prior to removal at a site provides more information on waste type and volume so that accurate contract documents can be prepared and a safe and efficient removal operation can be conducted. Unit price contract documents can be prepared with limited sampling data if sampling was done to verify the disposal categories and volumes of waste.

Data from a sampling program and laboratory analysis would include:

- Volume of waste
- Type of waste (solid, liquid, sludge, etc.)
- Presence of stratified layers in tanks
- Chemical composition of wastes in tanks (and possibly randomly selected drums)
- Characterization of waste by disposal categories (Section 2.4)
- Correlation between drum labels or shipping manifests and drum contents
- Waste compatibility or treatability (Section 2.4)

Techniques

Detailed drum and tank sampling procedures previously developed are presented in the references listed later in this manual (Section 5). Additionally, examples of drum handling and sampling, special waste handling, and tank sampling protocols used during remedial actions at an NPL site are included in Appendix B and C. Suggested guidance provided in these appendices should be tailored to fit the structure of the planned sampling activities and site-specific requirements.

As waste sampling is being performed, many of the compatibility tests can be performed on-site to reduce turn-around time and make drum staging (if necessary) more efficient. However, most compatibility testing will focus on tank wastes since it is typically the practice to sample all tanks whereas random sampling is only performed on drums.

Because there are generally fewer tanks present on-site, and tanks are usually more accessible than drums, the tank inventory and sampling process may be simplified. In most cases, it is possible to sample and inventory all bulk storage tanks during the limited RI. This information will be valuable in determining the appropriate type of treatment and disposal technologies for the tank wastes and preparing contract documents.

Limitations

Very strict health and safety procedures should be followed during all field activities of the limited RI, particularly during sampling activities (Section 2.4).

2.4.5 REVIEW ANALYTICAL RESULTS FOR CONFORMANCE WITH QA/QC PROGRAM

Purpose

EPA has developed QA/QC protocol and evaluation methodology to verify the accuracy and reliability of analytical data. The analytical data generated during the limited RI must be examined in accordance with these methods to assure their reliability and subsequent usefulness.

Techniques

Step-by-step QA/QC validation protocol have been developed by EPA (Section 2.4.2.3).

Limitations

Not applicable

2.4.6 EVALUATE ALL DATA AND PREPARE LIMITED REMEDIAL INVESTIGATION REPORT

Purpose

The evaluation of data is an ongoing process throughout the limited RI. However, once all field work has been completed and the data base is essentially complete, a final analysis is conducted. The activities of the limited RI and the results of the data evaluation are then presented in a remedial investigation report. During this final analysis the scope of the limited RI/FS is again reviewed.

Techniques

This evaluation of data should focus on the needs of the limited FS (described in Section 3). The objectives of various data collection activities are reviewed and then compared to the actual results of the limited remedial investigation. It is important to ensure that the data obtained satisfies the earlier defined objectives. If the objectives have been adequately met, the quality of the limited FS, which is based upon data obtained during the limited RI, will be enhanced.

A remedial investigation report on the tank and drum operable unit should integrate and present a discussion of activities and observations made during the limited RI, and include an evaluation of these data. Detailed discussion of the contents of a limited RI report are presented in EPA guidance documents referenced later in Section 5.0. A typical report for a tank and drum site could contain (but is not limited to) the following major elements:

- Site Background Information
- Nature and Extent of Problem
- Limited Remedial Investigation Summary
- Overview of Report
- Demography

- Land use
- Natural Resources
- Climatology
- Updated Base Map
- Hydrogeologic Features
- Surface Features
- Tank(s) Features
- Drums Features
- Site Health and Safety Features
- Bench and Pilot Tests (if applicable)
- Potential Receptors
- Public Health Issues
- Environmental Issues
- References
- Appendices

Evaluations of the expanded data base could indicate that the magnitude and/or complexity of the hazardous waste and environmental problems at the site are too great to remain within the scope of the limited RI/FS approach. If this is the case, a full-scale, comprehensive RI/FS may need to be considered in lieu of a limited single operable unit approach.

Limitations

Not applicable.

3.0 LIMITED FEASIBILITY STUDY

There are four major components of the limited FS. These are:

- Identify major remedial technologies (Section 3.1)
- Screen initial remedial technologies (Section 3.2)
- Conduct detailed evaluation of potential remedial action alternatives (Section 3.3)
- Conduct comparative summary of potential remedial action alternatives (Section 3.4)

The process of identifying, reviewing, and screening remedial technologies is ongoing throughout limited RI/FS activities. During the limited RI phase, technologies that are potentially applicable to the site are identified. Then, as the limited RI progresses, site limitations and waste characteristics are identified which preclude various remedial measures. This screening leads to the list of remedial alternative strategies to be addressed in the limited FS.

There are two major screening and evaluation phases of the limited FS. The first phase involves the identification and screening of alternative remedial technologies for each major alternative strategy. During this phase the technologies are screened based on technical feasibility and reliability, costs, environmental and public health effects. The results of the first phase define the components of each alternative for remedial action.

The second phase involves the development and evaluation of complete alternative plans of remedial action. The evaluation in this phase is based on more detailed cost, environmental, public health, and technical data, along with a consideration of regulatory and institutional concerns.

It is important to understand the difference in the meaning of the two terms "technology" and "alternative". A remedial technology is typically

specific to a waste type or a group of similar waste types. For example, incineration is a remedial technology potentially applicable to organic materials. A remedial action alternative is specific, in this case, to an operable unit at a site. One remedial action alternative could be comprised of many different remedial technologies, e.g., an off-site alternative may involve the incineration of organic wastes, the treatment of aqueous wastes and the land disposal of various sludges and solids.

A limited FS is a necessary and logical element in the procedure to develop specific remedial action alternatives for an NPL site. The purposes of a limited FS for a drum and tank site are:

- To identify technologies or remedial measures which are most appropriate for implementation at the site. Within each remedial measure further analysis may be required to evaluate the cost effectiveness of alternative remedial technologies (e.g., high temperature incineration, recycle, etc.)
- To develop alternatives to abate, stabilize, or minimize release of wastes from drum and tank sites
- To evaluate the cost-effectiveness of alternative remedial measures for treatment, storage, disposal or destruction of wastes within drums and tanks at a site
- To incorporate these technologies or remedial measures into overall remedial action plans for the site and evaluate their comparative features.

This evaluation and selection process must be consistent with CERCLA and Section 300.68 of the National Contingency Plan (NCP).

Specific guidance for conducting feasibility studies at NPL sites can be found in EPA's Guidance Document for Feasibility Studies Under CERCLA (EPA, 1985). Guidance for conducting feasibility studies under CERCLA and procedures for evaluating hazardous waste sites with surface tanks and drums are contained in the literature (See references for Sections 3.2, 3.3, and 3.4 that are presented in Section 5). This section presents an

approach for conducting a limited FS at a surface tank and drum site. A guidance logic diagram which displays the sequence of tasks is presented as Figure 3-1.

This section is organized to correspond to the individual tasks shown in Figure 3-1; text subsection numbers for these tasks are directly cross-referenced to the figure to provide easy orientation for the user.

For planning purposes one can assume that a calendar period of 1-2 months would be required to complete a limited FS. One should also assume that the limited FS can begin during the limited RI. The time requirements for the various tasks will vary from site to site.

3.1 IDENTIFY MAJOR REMEDIAL TECHNOLOGIES

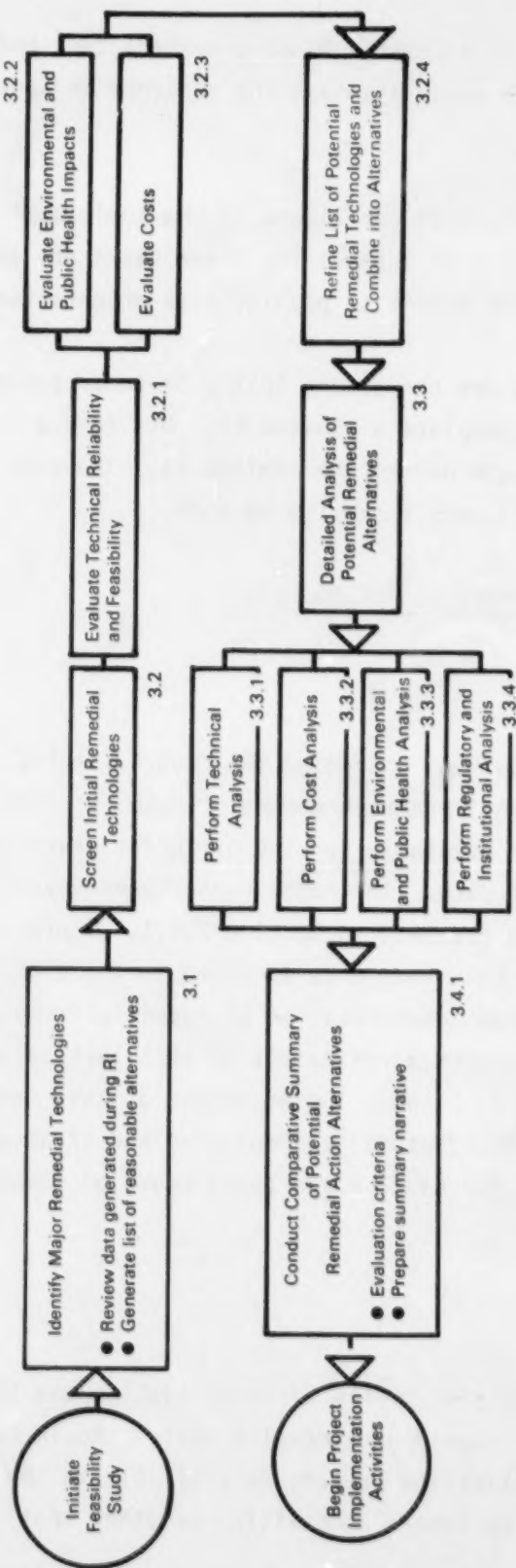
Purpose

The purpose of this task is to review the data collected as part of the limited RI and to identify the conceptual treatment and/or disposal technologies and strategies available for the different waste types found at a surface tank and drum site. The major waste types which would be defined in the limited RI are reviewed in Section 2.4.1. A preliminary review of potential remedial actions would be included in the limited RI. This review would include an identification of potential remedial technologies (Section 2.2.4) along with a refinement of this list based upon unavoidable and restrictive site features. The objective of this task is to further identify and define "conceptual" technologies and strategies which are potentially feasible for major waste types known or suspected in drums and tanks.

Techniques

During this task, the possibility of consolidating the individual waste types into a smaller number of composite wastes should be evaluated. It is essential that consolidation procedures available in the literature be confirmed in the field by sample compositing or other small scale techniques.

Figure 3-1. Feasibility study logic diagram.



Data available from the sampling program conducted in the limited RI (Section 2.4.4) should be used to evaluate the potential for waste bulking. A more detailed discussion of bulking is presented in an example bulking consolidation protocol, included as Appendix C.

The user should identify the remedial technologies that address cleanup of the project site with respect to the contamination migration pathways. For surface tanks and drum sites, remedial technologies are primarily those which provide for direct control of the wastes. Conceptual technologies can be different for tanks than for drums. Materials stored in tanks have the potential for a broader spectrum of control technologies because:

- It is more cost-effective to manage bulk quantities than small drummed quantities
- Experience has shown that there is more uniformity to wastes in a tank because the material was either a raw product or had the potential for recycling or incineration. Bulking in tanks from drums or bulk shipments was typically done at these sites to maintain a certain quality or characteristic for reuse or processing for reuse.

Typical conceptual technologies for various categories of drum and tank sites include:

- Physical/chemical/biological treatment (or pretreatment) to reduce the hazard
- Incineration to destroy the waste
- Processing, such as solidification, then land disposal (review current policy with EPA and regulatory agencies)
- Deep well injection (review current policy with EPA and other regulatory agencies)
- Recycle and reuse with or without pretreatment
- Direct land application (review current policy with EPA and other regulatory agencies)

The designation of appropriate treatment methods will depend largely on the form of wastes (e.g. solid, liquid, or sludges) and concentration of the

waste materials as well as various site characteristics. Hence, special attention may have to be directed toward the evaluation of physical phase separation procedures as a means of increasing waste suitability for a particular disposal option.

A matrix has been developed to relate the type of wastes to be handled at drum and tank sites to the types of waste treatment and disposal systems available. The treatment methods available for review are shown in Table 3-1. Only those treatment methods which have potential applicability to a given waste type and/or disposal categories (based on best engineering judgment and past experience) should be reviewed. This information has been developed as a planning guide and assigned designations should always be re-evaluated in terms of waste and site specific information.

Each activity or option has been designated either: (1) a reasonable option, or (2) a non-reasonable option. A "reasonable option" designation is given for a particular waste if, from a technical perspective, a treatment/disposal option has been shown to be feasible and reliable. For example, the treatment of aqueous wastes from an uncontrolled hazardous waste site by physical/chemical processes has a fairly well established "track-record." A non-reasonable designation is given for a particular waste stream when a treatment/disposal option would not be technically feasible for a drum and tank site or is only feasible under unique conditions.

After an initial determination of the technical feasibility of a remedial technology, a determination should be made of whether the alternative is either prohibited from selection as a matter of law (such as off-site disposal of hazardous waste from a Superfund site at a facility not in compliance with Subtitle C of RCRA) or is otherwise inconsistent with another environmental standard. An alternative which is legally prohibited for Superfund actions may not be selected. On the other hand, identification of an apparent inconsistency with another standard or criteria does not rule out selection of an alternative but should trigger a more thorough inquiry into the ability of that alternative to achieve adequate protection of health and the environment. EPA has proposed a

TABLE 3-1 CATEGORIES AND POTENTIAL TREATMENT/DISPOSAL TECHNOLOGIES

TANK AND DRUM WASTE CATEGORIES	ON-SITE PREP ACTIVITIES			TREATMENT AND DISPOSAL									
	Boiling/ Condensation	Absorption/ Solidification	Physical/Chemical Pre-treatment	Solidification/ Chemical Fixation	Detonation	Physical/Chemical Treatment	Biological Treatment	Land Application	Secure Landfill	Incineration/Thermal Reduction	Recycle/Reuse w/ Treatment	Recycle/Reuse w/o Treatment	Deepwell Injection
AQUEOUS WASTES													
• Acid: pH < 2.0	1	2	1	2	2	1	2	2	2	2	1	1	1*
• Base: pH > 12.0	1	2	1	2	2	1	2	2	2	2	1	1	1
• Base with Sulfur	1	2	1	2	2	1	2	2	2	2	2	2	2*
• Base with Cyanide	1	2	1	2	2	1	2	2	2	2	2	2	2*
ORGANIC LIQUIDS													
• High Halogen content (>2%)	1	2	2	2	2	2	2	2	2	1	2	2	2*
• Organic liquids including Low Halogen content (0-2%)	1	2	2	2	2	1	1	1	2	1	1	2	2*
• Oil: non-PCB contaminated	1	2	2	2	2	1	1	1	2	1	1	1	2
• PCB Contaminated Liquid (50-500 ppm)	1	2	2	2	2	1	2	2	2	1	2	2	2
• PCB Contaminated Liquid (> 500 ppm)	1	2	2	2	2	1	2	2	2	1	2	2	2
CONTAMINATED WATER													
• 2 < pH < 12	1	2	1	2	2	1	2	2	2	2	2	2	1*
• Inorganic	1	2	1	2	2	1	2	2	2	2	2	2	1*
• Organic	1	2	1	2	2	1	1	1	2	2	2	2	1*
• PCB Contaminated Liquid (< 50 ppm)	1	2	2	2	2	1	2	2	2	1	2	2	2
• Pesticide	1	2	1	2	2	1	1	2	2	2	2	2	2
SLUDGE/SOLIDS													
• Organic Low Halogen	1	1	1	1	2	1	1	2	1	1	2	2	2
• Organic High Halogen	1	2	2	2	2	1	1	2	1	1	2	2	2
• Inorganic	1	1	1	1	2	1	2	2	1	2	2	2	2
• Flash point (<70 °F)	2	2*	2	2	2	2	2	2	2	1	2	2	2
• Flash point (>70 - 140°F)	1	2	2	2	2	2	2	2	1*	1	2	2	2
• Flash point (> 140 °F)	1	1	1	1	2	1	2	2	1	1	2	2	2
• PCB Contaminated Solid (<50 ppm)	1	1	2	2	2	1	1	1*	1	1	2	2	2
• PCB Contaminated Solid (>50 - 500 ppm)	1	2	2	2	2	2	1	2	1*	1	2	2	2
• PCB Contaminated Solid (>500ppm)	1	2	2	2	2	2	1	2	1*	1	2	2	2
• Pesticide	1*	2	1	2	2	1	2	2	1	1	2	2	2
• Petroleum Residues	1	1	1	1	2	1	1	1	1	1	1	2	2
SPECIAL WASTES													
• Radioactive	*	*	*	*	*	*	*	*	*	*	*	*	*
• Strong Oxidizer	2	2	1	2	2	1	2	2	1	2	2	2	2
• Strong Reducer	1	2	1	2	2	1	2	2	1	2	2	2	2
• Lab Packs	2	2	2	2	1*	1	2	2	1	1	2	2	2
• Explosives	2	2	2	2	1	1	2	2	2	1	2	2	2

Phased waste shall be separated and handled as individual waste items.
Mixed waste shall be classified under the more restrictive disposal category.

1 = Reasonable Option

2 = Not Reasonable (impractical, Technically Infeasible)

* = Further detailed analysis is warranted

policy on compliance with other environmental laws which, when final, would restrict EPA from selecting alternatives which did not attain or exceed applicable or relevant federal standards, except in certain limited circumstances."

The delineation of on-site or off-site treatment processes is also important from a planning perspective. In some cases the designation for similar waste classes and treatment/disposal options indicate that on-site options are not as favorable/reasonable as off-site options for tank and drum sites. The following issues summarize the reason for this difference:

- Off-site options are usually already existing and design, capital, and start-up costs and schedule considerations are not a factor.
- Infrastructure, i.e. utility, support requirements for some on-site treatment/disposal options may be difficult to satisfy on some sites.
- Physical site features may be restrictive for on-site activities.
- Temporary on-site or mobile facilities may not have the through-put capability of more permanent off-site facilities.
- The off-site cost may be considerably less since the capital costs for a facility erected on-site should be credited entirely to the waste managed at that site, whereas if an off-site alternative is selected, the capital costs are spread over all uses of the facility over time. Even though transportation costs must be incorporated into an off-site alternative, this is often far outweighed by capital costs, review schedules and practicality.
- On-site disposal would require extensive engineering and design, and may include meeting post-closure monitoring and maintenance requirements. These factors render on-site disposal more difficult from cost, schedule and effort perspectives.

On-site treatment may be limited to pretreatment for the purpose of consolidating specific waste types or characteristics such as phase separation, coalescing for oil extraction, chemical incompatibility, neutralization, solidification and bulking.

The types of solidification/fixation technologies that could be used for either on or off-site are dependent on two basic properties of the waste: 1) physical state, i.e. liquid, sludge and solid, and 2) chemical nature,

i.e. organic and inorganic. The application of these technologies is directly related to the final disposal of the material. Solidification generally refers to techniques that reduce the leachate production potential by physical processes whereas fixation techniques typically reduce leachate potential by chemical processes. These terms are often used interchangeably and both are often referred to as stabilization techniques.

In many cases, the relative cost per volume (or economy of scale) to provide the extra handling and meet the analytical requirements for chemical fixation can be very high. Chemical fixation is more widely applicable for inorganic wastes such as, fly ash, scrubber residue, and metal tooling and plating by-products. The inorganic wastes can be readily mixed with lime, fly ash and ready-mix concrete. Solidification/fixation technologies have been more widely applied to inorganic wastes than organic wastes, however, some developing techniques have been successfully applied to various types of organic wastes. Solidification/fixation of wastes can be performed either on or off-site and is typically appropriate before final disposal.

Commonly utilized off-site treatment and disposal systems include physical/chemical treatment, land disposal, and incineration. Recycle/reuse has limited applicability for drum wastes, because one would not expect to find significant volumes of "pure" waste. It can be more readily applied to tank wastes, in part because of the larger volume and consistency of waste.

Where unusual or uncertain waste characterization or composition makes determination of probable treatment efficiencies questionable, it may be necessary to conduct bench-scale treatability studies or other tests in order to ensure full-scale success. For example the BTU value of a waste may need to be determined if incineration costs are to be accurately developed or knowledge of the percent solids of a sludge may be necessary for the evaluation of some technologies. Additionally, a study utilizing a

small activated carbon column may be conducted to determine removal efficiency for various organics. Evaluated treatment systems which require such pilot- or bench-scale verification should be identified, along with the time and materials needed for their execution.

Planning for the handling of empty drums should also begin at this stage of the limited FS. Depending upon waste characteristics and earlier uses and activities at a site the condition of drums can vary. Some drums may be severely deteriorated and highly contaminated, while others may be clean and never used. Typically, an empty drum is defined as a drum which has one inch or less of residue left in the bottom of the drum (refer to 40 CFR 261.7 for further details). If the drum is not cleaned further it can be crushed and disposed of as a bulk hazardous waste. If the drum is cleaned it may be recycled/reused or disposed of (possibly in other than a hazardous waste landfill). The cleaning requirements are very strict (refer to 49 CFR 173.28) for the reuse of drums that contained hazardous waste. The cost of drum cleaning would have to be balanced with the alternative cost of crushing and direct disposal.

3.2 SCREEN INITIAL REMEDIAL TECHNOLOGIES

Section 300.68(h) of the NCP requires that these potential technologies be screened using the following criteria:

- Technical, reliability and feasibility (Section 3.2.1)

As a result of the technology screening, inappropriate technologies are eliminated from further detailed analysis. The remaining technologies are screened for:

- Environmental and public health impacts (Section 3.2.2)
- Cost (Section 3.2.3)

For a simple site, one that has a few hundred drums and one or two above-ground storage tanks, the user should proceed directly to Section 3.3 because the low volume typically limits the applicability of many options.

3.2.1 EVALUATE TECHNICAL RELIABILITY AND FEASIBILITY

Purpose

The purpose of this task is to evaluate the feasibility and reliability of the remedial technologies given the location and conditions of the hazardous waste site and of the surface tanks and drums on the site. Additionally, potential limitations due to state-of-the-art applications or limited "track record" will be defined.

Techniques

The user should identify the level of technology development, performance record, and inherent construction, operation, and maintenance problems for each technology considered. An example of an unreliable technology might be an off-the-shelf process or package system that is waste specific. On many drum sites the waste is not homogeneous. On such wastes, waste-specific process trains would have a limited application. Technologies which are unreliable, offer inferior performance, or are not demonstrated processes should be eliminated from further consideration. Technologies available at permitted off-site waste management facilities can, for the most part, be considered proven technologies.

Technologies that are in experimental or developmental phases may be acceptable, however, they should be evaluated very carefully particularly with regard to waste specificity restrictions. Experimental processes for a drum and tank site could include on-site, bio-assimilation, or any such "treatment" process with unique performance requirements. In order to get a reasonable estimate on technical reliability and feasibility development, or experimental processes, may require fairly extensive pilot testing. Some may show promise on a specific waste stream or in test operation. In most cases, however, these could only handle a fraction of the material

(particularly drum wastes) found at the site because of the very heterogeneous nature of wastes and specificity of many treatment processes. The potential applicability to large volumes of homogeneous tank waste may be better than for use on drum wastes.

Limitations

Limitations of various remedial technologies applicable to surface tank and drum sites are presented in Planning and Implementation of Response Actions for Hazardous Waste Sites with Drums, U.S. EPA, Contract No. 68-03-3113. A general screening methodology for evaluating the limitations of remedial technologies at any type of site (not necessarily a tank and drum site) is presented in the Handbook for Remedial Actions at Waste Disposal Sites (EPA, 1982).

3.2.2 EVALUATE ENVIRONMENTAL AND PUBLIC HEALTH EFFECTS

Purpose

The purpose of this task is to evaluate the identified technologies that have significant adverse environmental effects and/or are not likely to achieve adequate control of the hazardous wastes at the surface tank and drum site. Potential positive environmental features should be defined as well.

Techniques

As indicated, this analysis should focus on both negative and positive impacts. Some alternative technologies may have emissions/discharges requiring careful control, while others may require more materials handling and increase the risks of exposure or accidents. From a positive or beneficial impacts perspective, some technologies could be more effective in site cleanup and/or waste destruction.

Potential adverse environmental and public health impacts which may preclude the use of an alternative should be identified. This is most effectively accomplished by conceptually identifying the major steps involved in implementing each alternative and then determining if any will result in adverse environmental or public health impacts. Positive impacts of an alternative should be considered against any potential adverse impacts from an alternative's implementation. Representative site and waste characteristics which could be considered in this analysis are presented in EPA's Guidance Document for Feasibility Studies Under CERCLA (EPA, 1985).

Inconsistency with other environmental requirements, such as the following examples, may indicate that an alternative may not adequately protect public health and the environment.

- Air emissions of chemicals that would exceed Clean Air Act regulations or state requirements for toxic compounds
- Discharges to surface soils that would exceed land disposal regulations
- Discharges to ground water that would violate federal or state regulations
- Discharge to surface waters that would violate any applicable federal or state regulations

Limitations

When conducting this environmental screening, certain limiting factors should be considered to control the level of effort expended. Due to the limited scope of typical operations, major environmental issues are not usually expected from drum and tank remedial actions. For example there would be little excavation of material that would enhance the volatilization of organics.

The objective of the evaluation is not to extensively evaluate substantially similar technologies but rather to consider the major differences between alternatives. For example, similar on-site alternatives can be eliminated if those technologies being considered will result in unacceptable discharges to the environment. It should be noted that this analysis pertains to on-site remedial actions and transport to off-site facilities. It is assumed that off-site treatment and disposal would be performed in compliance with all applicable environmental regulations by regulatory permit conditions.

3.2.3 EVALUATE COSTS

Purpose

The objective of cost screening is to evaluate identified technologies, and define those that have costs which are significantly greater (e.g., an order of magnitude) than other alternatives, and do not provide substantially greater environmental or public health benefits.

Techniques

The screening can be divided into three basic tasks: (1) estimation of costs for each technology; (2) present worth analysis of each technology, if applicable, and (3) cost comparison of the technologies.

Costs consist of all financial outlays required for implementation of the action including engineering, design, construction, operating and maintenance expenditures, general and administrative expenses, material transportation and disposal, and other costs as appropriate. Major cost categories and components of cost categories are highlighted in the Guidance Document for Feasibility Studies under CERCLA (EPA, 1985).

Additional costs may exist, depending upon the particular remedial alternative under investigation. These costs should be identified and evaluated on a case-by-case basis. Also, there may be situations where revenues

could be realized as a result of some recovery value of a particular waste and these would be considered in the cost analysis.

A present worth analysis may be necessary to compare alternatives that have expenditures which occur over different time periods. EPA's Costing Procedures Manual should be referenced for procedures on conducting present worth analysis.

The focus of this screening analysis is on relative differences in costs. Therefore, the required detail is not as extensive as a more comprehensive design/feasibility type study.

Limitations

When preparing screening cost estimates, the objective in calculating the costs is to achieve at least an accuracy of -50 to +100 percent.

3.2.4 REFINES LIST OF POTENTIAL REMEDIAL ACTION ALTERNATIVES

Purpose

This task consolidates the results of the screening activities described in tasks 3.2.1, 3.2.2, and 3.2.3. The principal objective during this task is the development of a list of potential remedial action alternatives that appear reasonable in terms of:

- Technical feasibility and reliability
- Minimizing actual or potential environmental and public health impacts from the tanks and drums
- Capital, operation and maintenance costs

Techniques

Treatment technologies with severe constraints due to design limitations, marginal track records or application to only a small fraction of the waste would be initially screened from the candidate list of potential

technologies. Further screening using the criteria of preliminary cost, general environmental and public health effects would eliminate those technologies with relatively poor ratings from further consideration. Technologies with high relative costs with no significant environmental or technical benefits should be screened out. Those options with unacceptable adverse environmental impacts or public health risks would be eliminated.

The remaining technologies would have no major limitations from a technical feasibility and reliability perspective while at the same time appearing reasonable in terms of cost and environmental and public health issues. These remaining technologies would be combined to form various alternative remedial actions for handling the identified tank and drum waste found on-site.

The categories of basic remedial alternative strategies should include:

- Alternatives for off-site treatment or disposal
- Alternatives which attain applicable or relevant federal public health and environmental standards
- Alternatives which exceed applicable or relevant federal public health or environmental standards
- Alternatives which do not attain applicable or relevant federal public health or environmental standards but will substantially reduce the likelihood of present or future threats from hazardous substances
- Consideration of the no action alternative to assess the public health and environmental threats that exist at a particular waste site

Limitations

There may be a tendency to "over analyze" the potential list of alternatives in terms of the previously defined screening criteria. This entire screening process should not require a very detailed and/or laborious effort. Many of the relative ratings and decisions can be based upon good engineering, economic, and scientific judgments and experience.

3.3 CONDUCT DETAILED ANALYSIS OF POTENTIAL REMEDIAL ACTION ALTERNATIVES

The objective of this detailed analysis is to develop sufficient information to permit the comparative evaluation of alternative remedial actions and, if requested, recommend a remedial action for a specific drum and tank site. In order to address the evaluation criteria outlined in the NCP, four major areas of analyses are recommended in the evaluation of alternative remedial actions:

1. Technical features (Section 3.3.1)
2. Costs (Section 3.3.2)
3. Environmental and public health features (Section 3.3.3)
4. Regulatory and institutional issues (Section 3.4.4)

Depending upon the complexity of the tank and drum site, this evaluation of alternative actions should proceed in a straightforward and timely manner. The evaluation is not meant to be exhaustive but rather provide sufficient documentation for the support of a remedial action.

3.3.1 PERFORM TECHNICAL ANALYSIS OF ALTERNATIVES

Purpose

The purpose of the technical analysis will be to evaluate the potential remedial action alternatives from an engineering standpoint. To ensure that specific technical criteria are met, emphasis will be placed on proven technologies. Even with proven technologies, a significant degree of variation can exist between the success of techniques for different wastes and in different hydrogeological/site specific settings.

Techniques

The user should evaluate each of the remedial action alternatives to specify major equipment sizes and specifications, personnel and utility requirements, and specific waste disposal strategies. Using the

information developed, the user should compare the alternative actions using the following technical criteria:

- Performance - Effectiveness in accomplishing design objectives, useful life
- Reliability - Dependable in meeting design objectives, degree of O&M requirements to keep operational
- Implementability - Suitable conditions for construction (both on-site and external to the site), time (to implement, to achieve beneficial results)
- Safety - On-site personnel, nearby communities, and surrounding environment

A tabular summary can be useful for presenting the key positive and negative features of an alternative within each of the technical evaluation criteria.

Additional guidance regarding the details of appropriate technologies for actions at tank and drum sites and use of the technical comparison criteria is available in the referenced literature (Section 5). Specific information on particular technologies and procedures can also be obtained from vendors, equipment manufacturers, and cleanup contractors.

Limitations

The "track record" of some innovative and proprietary techniques for remedial action is often very limited. Therefore, the database for evaluating their reliability, performance and implementability can be scarce. One should not unnecessarily expand the scope of technical analyses with a search for data on unproven technologies. Good engineering judgment should be made based upon the data obtained from vendors, literature, and cleanup contractors.

3.3.2 PERFORM COST ANALYSIS OF ALTERNATIVES

Purpose

The purpose of this analysis is to develop cost estimates for the alternative remedial actions using the information developed during the technical analysis of these alternatives. These cost estimates are site-specific and provide the basis for comparing the economic features of various remedial actions, not for budgeting the cleanup effort.

Techniques

Costs consist of all capital outlays, operating and maintenance expenditures, general and administrative expenses, and other costs required for implementation of the action including engineering, design, and installation, as appropriate. Cost data developed during the screening analysis of remedial technologies are very useful and applicable for this more detailed analysis.

EPA's draft Compendium of Cost Remedial Technologies at Hazardous Waste Sites (EPA, 1984) reviewed cost categories unique to drum sites. Base costs were defined considering three broad categories:

1. Drum removal (including retrieval, staging, overpacking, and loading)
2. Transportation (on-site handling, demurrage and off-site transport)
3. Ultimate disposal/treatment (tipping fees, surcharges and taxes)

Items were defined which affect the cost within each of these three broad categories. For example, drum removal costs were affected by drum condition, waste type, drum size, access, etc.; transportation was basically influenced by material weight and volume relative to distance; and disposal and treatment were influenced by both the physical and chemical characteristics of the waste.

When evaluating the cost-effectiveness of various approaches or alternatives, many scenarios must be considered and flexibility should be maintained.

For example, there are various factors which can influence the overall cost for handling and treating/disposing drum wastes. Some general items one should consider when reviewing various scenarios are summarized below:

- It is generally less expensive to handle and transport drum waste if they are bulked as compared to overpacked
- Disposal facilities generally charge more to handled drummed waste than an equivalent amount of bulked waste
- Compatibility limitations of various wastes will restrict the amount of drum waste that can be bulked

There are many similar cost components for both on- and off-site remedial alternatives. For example, drum staging and sampling, and many site preparation/mobilization costs are similar. However, there are some major cost components which are different for both on- and off-site approaches. For example, transport requirements could be a major cost component for an off-site alternative, whereas an on-site alternative may have relatively minor transport costs.

To analyze the costs for each alternative remedial action, the user should perform the following steps:

- Estimation of Costs - estimate capital (direct and indirect) and annual operating and maintenance costs of the remedial alternatives.
- Economic Analysis - using estimated costs, calculate stream of payments and present worth for each remedial action alternative (for most short-term remedial actions, e.g., six months, this is not a major concern unless there are long-term maintenance and/or monitoring requirements).
- Sensitivity Analysis - evaluate risks and uncertainties in cost estimates.
- Input to Cost Analysis - identify input data and reliability necessary to evaluate costs of remedial action strategies.

Information regarding the procedures involved with these steps is presented in the Guidance Document for Feasibility Studies under CERCLA (EPA, 1985). References listed in Section 5.0 provide additional information on the costs of different technologies. This information, plus vendor/contractor input, should be used to develop the cost estimates. Additionally, the results of remedial activities at other tank and drum sites can provide cost data which are very useful for comparative purposes. A range of discount rates may be useful during the sensitivity analysis.

Limitations

The objective in calculating the costs is to achieve an accuracy within -30 to +50 percent. Failure to adequately estimate the cost for items such as contractor mobilization/demobilization, stand-by-costs, as well as waste transportation and disposal and laboratory analyses can substantially impact this objective.

A potential area of cost uncertainty is the estimated quantities for various waste disposal categories (based upon the data obtained during the limited RI). The basis for conducting random sampling is presented in Section 2.4 and while providing useful information, the applicability of the data for some uses can be limited. Depending upon the approach of any previous drum sampling, one should define the confidence limitations of extrapolating projections for the entire site from a potentially limited database. As long as one is aware of the potential limitations of the database, this knowledge can be applied consistently for all alternatives reviewed. This is particularly important to consider in the cost analysis of alternatives that are particularly sensitive to the estimated quantities of particular wastes.

3.3.3 PERFORM ENVIRONMENTAL AND PUBLIC HEALTH ANALYSIS

Purpose

Section 300.68(j) of the NCP requires that the alternative remedial action selected for implementation at a surface tank and drum hazardous waste site effectively mitigate and minimize damage to and provide adequate protection of public health, welfare, and the environment. This activity, as required by the NCP, evaluates the effectiveness of alternative remedial actions in terms of environmental and public health issues. This analysis not only focuses on the mitigative effectiveness of alternatives but also considers possible positive and negative secondary/indirect effects.

Techniques

For the particular site and alternative remedial actions being considered, the user must first make three basic determinations. These are:

1. The requirement for an environmental assessment of adverse impacts
2. The level of detail required in the assessment
3. The scope of the assessment

The environmental analyses for drum and tank sites are fairly straightforward. On-site remedial alternatives typically require more detailed environmental analyses than off-site alternatives. For both concepts there are many similar areas of concern, such as spillage and volatile emissions during drum handling and staging. Additionally, reuse or destruction, whether on- or off-site, is environmentally desirable.

On-site remedial actions should go through a fairly extensive environmental review. An area of concern for on-site disposal is the risk and potential effect of failure (e.g., if a liner and leachate collection system fails, will wastes migrate during high ground water conditions?).

Off-site remedial actions involve receiving facilities and transport operations. Environmentally sensitive areas along nearby transport routes have to be considered, along with potential impacts at the final site of treatment and/or disposal.

The Guidance Document for Feasibility Studies under CERCLA (EPA, 1985) provides information regarding these determinations. Literature cited in the references provides useful information regarding implementing and summarizing the assessment.

Limitations

This analysis should not be an exhaustive research exercise. It's focus should be clearly on effectiveness of alternatives in mitigating potential environmental and public health issues of concern.

3.3.4 PERFORM REGULATORY AND INSTITUTIONAL ANALYSIS OF ALTERNATIVES

Purpose

This analysis allows a comparative review of the extent to which those alternatives under consideration are consistent with other environmental requirements and take into account various institutional constraints.

Techniques

The user should identify and meet with the appropriate officials at the federal (regional), state, and local levels to discuss the alternative remedial actions being considered for the surface tank and drum site.

Information on the responsibilities, authorities, and potential roles of federal agencies during the planning and implementation of a remedial action is presented in Guidance Document for Feasibility Studies under

CERCLA (EPA, 1985). EPA is developing policy on the use of permanent remedies (such as treatment or destruction) and addressing when disposal in double-lined facilities are appropriate.

In determining what cleanup levels or technologies provide adequate protection of public health and the environment, EPA considers other environmental laws and regulations that are applicable or relevant to the site. EPA has proposed a policy which would require cleanup actions to be consistent with these other laws and regulations except when certain specified situations exist.

Off-site storage, treatment, or disposal facilities must have an applicable RCRA permit or be in compliance with RCRA. A RCRA compliance inspection must have taken place within the previous six months and must demonstrate that there are no significant violations that affect the satisfactory performance of the facility.

In selecting an operable unit, which is not by itself the final action necessary at a site (such as cleanup of drums and tanks at sites where contaminated soil or ground water exists), the decision document will indicate what additional problems will be addressed in future operable units.

Limitations

Environmental permits are not required for on-site Superfund remedial actions.

3.4 CONDUCT COMPARATIVE SUMMARY OF POTENTIAL REMEDIAL ACTION ALTERNATIVES

Purpose

The National Contingency Plan (NCP), Section 300.68(j) states: "The appropriate extent of remedy shall be determined by the lead agency's selection of the remedial alternative which the agency determines is cost-effective." While an important objective is to keep costs to a minimum,

the primary goal of the program is to provide adequate protection of the public health and the environment. In addition, EPA considers which alternatives will be most cost effective in the long term, not just if a remedy just has lower initial capital cost. For example, the destruction or treatment of a waste may be preferred to land disposal even though the cost of the former may be higher. This decision would be based on the need to assure the long-term protection of the public health and the environment and taking into account the long-term cost of operating and maintaining the integrity of physical structures necessary to securely contain waste.

Techniques

The results of the detailed analyses of the alternative remedial actions should be organized and summarized for comparison. The analysis should be conducted with a precision that is consistent with the degree of knowledge about the problem or expected results. The framework must be tailored to meet the needs of each particular site evaluation by adapting the evaluation criteria to reflect site-specific conditions, hazards, or public concerns.

A summary table is a useful tool in organizing and presenting the results of a composite evaluation of remedial actions involving multiple criteria. A sample summary table for remedial actions at a hypothetical abandoned tank site is presented in Table 3-2. Accompanying the summary table would be a narrative explanation for each evaluation criterion, presenting the advantages and disadvantages for each alternative remedial action.

Limitations

Certain comparison criteria are qualitative and subjective. Thus, different perspectives may result in different comparison results. A tendency in these types of comparative evaluations is to over-emphasize the relative importance of a particular evaluation criterion, such as costs. However, increasing attention should be given to alternatives that are based upon the destruction, treatment, and/or reuse of the waste material.

TABLE 3-2
FINAL REMEDY FOR HYPOTHETICAL ABANDONED TANK SITE

ALTERNATIVE	COST	PUBLIC HEALTH CONSIDERATIONS	ENVIRONMENTAL CONSIDERATIONS	TECHNICAL CONSIDERATIONS	PUBLIC COMMENTS
A. No Action	\$ 0	- Tank will continue to deteriorate and overflow - Direct contact threat remains	- Underlying Class 1 aquifer threatened	- Not applicable	Highly opposed
B. On-site Treatment	\$3m	- Bulkling - Incineration of organics - precipitation and stabilization of metals - neutralization of corrosives - off-site sludge disposal	- Site operation above Class 1 aquifer - Discharge to stream - Transportation through populated areas (sludge)	- Incinerator must be designed and constructed or mobile - Sidestream management required	Mild opposition
C. Off-site Treatment	\$4m	- on-site bulkling - Incineration of organics - precipitation and stabilization of metals - neutralization of corrosives	- Transportation through populated areas (untreated wastes)	- Facility over 200 miles distance - Capacity limitation	Acceptable

This summary comparative analyses can provide the basis for this type of evaluation.

Depending upon the degree of confidence and the extent of the database for drums, it may be advisable to prepare two summary tables; one for tanks and the other for drums. The database for tanks will probably be more comprehensive. The database for drums could be limited to that obtained in the random sampling program (refer to Section 2.4.1).

3.5 PREPARE LIMITED FOCUSED FEASIBILITY STUDY REPORT

A draft FS report should be prepared that summarizes the feasibility study of alternative remedial actions for the surface tank and drum hazardous waste site. The typical section headings for this report are presented in Table 3-3. It is not necessary to limit the report to the listed items. In this report it is not necessary to provide details on site background if a full RI/FS is being conducted. A reference to this document with only a brief summary of a pertinent feature is appropriate.

The Guidance Document for Feasibility Studies under CERCLA (EPA, 1985) provides additional information regarding what should be included in the report and why.

TABLE 3-3
LIMITED FEASIBILITY STUDY REPORT

INTRODUCTION

- Site Background Information
- Nature and Extent of Problems
- Objectives of Remedial Action

SCREENING OF REMEDIAL ACTION TECHNOLOGIES

- Technical Criteria
- Environmental/Public Health Criteria
- Institutional Criteria
- Other Screening Criteria
- Cost Criteria
- Remedial Action Alternative Development

REMEDIAL ACTION ALTERNATIVES

- Alternative 1 (No Action)
- Alternative 2
- Alternative x

ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

- Non-cost Factors
- Technical Evaluation
- Environmental Evaluation
- Institutional Requirements
- Public Health Evaluation
- Cost Factors

SUMMARY ANALYSIS OF ALTERNATIVES

RECOMMENDED REMEDIAL ACTION (Optional)

4.0 TANK AND DRUM SITE REMEDIAL DESIGN/REMEDIAL ACTION

This section provides the reader with the basic approach and procedures of tank and drum site remedial action design. It is not intended to be a comprehensive guidance document on the development of contract (or subagreement) documents and the implementation of a remedial action. The user should consult EPA's Superfund Remedial Design and Remedial Action Guidance (February 1985) for a more complete manual on the design and construction requirements for Superfund activities. Federal-lead contracts should follow the Federal Acquisition Regulations (48 CFR Chapter 15 and 48 CFR Chapter 1, Subpart 1.3), while state-lead subagreements should follow the Agency's "Procurement Under Assistance Agreements" regulation (40 CFR Part 33). In addition, detailed guidance on state procurement under Superfund cooperative agreements can be found in Volume II of the manual State Participation in the Superfund Remedial Program to be issued in September 1985.

4.1 APPROACH

The normal method of executing site cleanup is to use either formal advertising or competitive negotiations to procure the services of a responsive and responsible contractor. In fact, on state-lead projects formal advertising must be used to procure construction services during remedial implementation unless the EPA official responsible for the obligation of funds (AA or RA) approves an alternative procurement method in advance. Formal advertising cannot be waived in the Superfund remedial program by a claimed emergency situation since EPA handles Superfund emergencies under the removal rather than the remedial program. Furthermore, a declaration of an emergency under state law does not necessarily constitute an emergency under the EPA Superfund program.

The owner must prepare contract documents which define the work to be done and provide a basis on which contractors competitively bid to perform the work. It is essential that these contract documents completely and

accurately define all the work required. The Construction Specification Institute (CSI) format may be used in preparation of contract documents for drum and tank sites. This format keeps hazardous waste site design and procurement consistent with the more conventional construction projects. The CSI format breaks the work into divisions. Division 0 establishes the general project and contractual procedures, and the technical specifications are included in Divisions 1 through 16 (see Section 4.4). Material presented in these sections focuses principally on issues involving tank and drum sites.

4.2 CONTRACTING PROCEDURE

The bidding and contract requirements define the conditions under which the contractor must perform the work for the owner (i.e., the entity which provides the funds). A number of pricing options may apply to a particular contract. These include firm fixed price (lump sum) or unit quantity and time and materials.

For fund financed remedial actions (state-lead projects), the recipient must use the formal advertising procurement method. Formal advertising requires, at a minimum, the following:

- A complete, adequate, and realistic specification or purchase description of what is required
- Two or more responsible bidders who are willing and able to compete effectively for the business
- A procurement that lends itself to the award of a fixed-price contract
- The selection of the successful bidder, made principally on the basis of price

4.2.1 FIXED-PRICE (LUMP SUM) CONTRACT

With this type of contract, the contractor responds with a single fixed cost price (which includes labor, overhead, and profit) to perform the work described in the project plans and bid documents. This method requires the owner to develop definitive performance specifications for the bidding

process and also requires the greatest amount of sampling and analysis to prepare the bid. This contract is applicable to such work as:

- Mobilization - This includes the up-front costs such as insurance, bonding requirements, obtaining project-specific licenses and permits, and the development of site-specific contingency and health and safety plans.
- Site Preparation - This includes typical conditions related to activities such as roadways, clearing, grading and staging areas and decontamination pad construction.
- Temporary Facilities - These include support facilities such as trailers, clean zone equipment, laboratory and utility hook-ups.
- Demobilization - This provides for the payment of basic closure costs for decommissioning of utilities, final grading and reporting requirements

4.2.2 UNIT PRICE CONTRACT

This type of contract requires that the owner estimate quantities of materials to be disposed of or treated in the bid documents. Potential contractors bid on a per unit basis which includes labor, overhead, and profit.

Unit pricing is more applicable to the waste handling and disposal areas of the work. The basic concept provides for a fixed unit price, per gallon, cubic yard and/or tons, to be set at the time of bid. This unit price would be applied or spread over an estimated quantity of units rather than a set quantity, since on a tank and drum site only a very small percentage of the containers may be sampled or even opened. Waste categories and quantities are estimated based on site history and previous experience. These quantities are only estimates; the actual quantities on-site will not be known until the last container is removed. Therefore, the unit price system provides a mechanism for the contractor to be paid for all quantities found, independent of any deviation from original estimates.

Unit pricing requires that the price quoted for each unit include the cost for on-site material handling, laboratory analysis, labor and equipment, repacking/overpacking, on-site consolidation and building, manifesting and

off-site transfer, and off-site treatment and/or disposal. These price quotes are generally considered firm unless there is a significant change in conditions or, more specifically, if there is a major increase or decrease in the original estimate. The basically accepted rule of thumb is to provide a 15 percent margin. Deviations above or below this margin would lead to renegotiation. In developing the unit price bid, the contractor will generally spread fixed costs evenly over the original estimated quantity. Therefore, if the actual quantity significantly underruns the original estimate, the contractor will not receive compensation for all of the fixed costs incurred. If the quantity is much greater than the original estimate, the owner may be entitled to a cost reduction. Adjustments in price occur through negotiation at the time the change is recognized. The unit price concept provides a basis by which bids can be compared and maintains a built-in flexibility to accommodate change.

4.2.3 TIME AND MATERIALS CONTRACT

Under this type of contract, the contractor is paid a fixed rate (including labor, overhead, and profit) for each hour performed and actual cost of materials. Because this contract contains the least incentive to perform efficiently, it should be used if no other contract is suitable.

It reimburses the contractor for all costs incurred for a specific scope of work. This approach does not provide a mechanism by which bids may be compared, and it requires a much greater level of management by the owner. The owner also assumes all of the risk under this option.

4.3 CONTRACT PROVISIONS

Provisions must be in a contract to address both the specific work items comprising the known project scope and the procedures for defining and handling out of scope activities. In addition, specific clauses or their equivalent are required in each contract by 48 CFR Chapter 15, and Chapter 1, Subpart 1.3 and/or 40 CFR 33 for fund-financed actions. As with any construction related contract, changes in the work may occur under a

hazardous waste site cleanup type contract due to differing site conditions.

4.3.1 CHANGE ORDERS

A change order is a written order issued by the owner or its designated agent to its contractor authorizing an addition to, deletion from, or revision of a contract. A change order is necessary to modify, within the scope of the project, the contract cost or scope of work; to interrupt or terminate the project; to revise the completion date; or, in general, to implement any deviation from the original contract terms and conditions. Change orders are issued after the execution of the contract. Proper management of change orders is a key element to avoiding delays, increased costs, and potential contractor claims.

Change orders may be required for the following conditions:

- Differing site conditions
 - Subsurface or latent physical conditions at the site differing materially from those indicated in the contract
 - Unknown physical conditions at the site, conditions of an unusual nature, or those differing materially from those ordinarily encountered and generally recognized as inherent in work of the type provided for in the contract
- Errors and omissions in plans and specifications
 - Errors are items which are described incorrectly on the plan or in the specifications
 - Omissions are items which are neither shown nor specified
- Changes instituted by changes in regulatory requirements, such as:
 - Changes requirements for protecting historical or archaeological objects
 - Revisions to building codes
 - Revisions to zoning and land use plans
 - Revisions to federal regulations and policies
 - New congressional legislation

- Design changes, such as modifications to existing design which will offer a savings in excess of all costs associated with the change order, including future operation and maintenance costs
- Overruns/underruns in quantities
- Factors affecting time of completion, such as:
 - Suspension of work (temporary)
 - Direct acceleration
 - Time extension for delay beyond the contractor's control
 - Constructive acceleration
- Changes in contract administration procedures, such as:
 - Progress payment terms
 - Retainage release
 - Occupancy
 - Testing
 - Acceptance
 - Warranties
- Resolution of claims
- Emergency conditions:
 - Acts of God
 - Civil disturbance

Tank and drum sites are unique in the that there are many unknowns about the conditions of the site and the waste that will be encountered, all of which may necessitate change orders. For example, if lab packs or other unique categories of waste materials (e.g., reactive or shock sensitive) are known or suspected to be on-site, then the contract document should specify such. However, when a contract includes specific provisions for unique site/waste conditions, but none are found, the contract should address limited compensation. While no unique or special site/waste conditions may be found, the contractor may have had to mobilize special

support equipment or plan for unique contingencies; for example, the construction of on-site temporary storage facilities along with the staging of special handling equipment for shock sensitive waste. These are legitimate costs which should be paid for by the owner even though no shock sensitive wastes are found. Another example calls for detailing the work by using the existing information. In this instance, a reasonably competitive price should be received for known and definable work items. Modifications, as they occur, can be handled by change order.

Ultimate responsibility for change order administration rests with the owner. Specifically, the owner is responsible for:

- Determining whether a contract change order is warranted, based on the terms of the existing contract and a review of the circumstances responsible for the alleged change
- Negotiating a fair and reasonable price for price contract changes
- Maintaining accurate and complete cost records for the change, including records of negotiation
- Adequately documenting for future reference a description of the agreed change and reason for this change
- Maintaining current and accurate fiscal projections of contract and project completion costs
- Executing contract change order documents efficiently and in a timely manner
- Resolving disputes which may arise as a result of a proposal for a change
- Assessing the impact of change orders on progress toward project completion and acting to mitigate resulting project delays

In order to expedite review and approval of change orders, contractors must:

- Adequately describe the reason for each change request
- Submit change order proposals in accordance with the procedures set forth in the contract documents, and enter into meaningful negotiations on a necessary contract change

- Furnish and certify the accuracy and completeness of cost and pricing data on enable the owner to determine the necessity and reasonableness of the cost proposed

Project delays and disputes resulting from change order administration can be limited by effective and frequent communication between the owner and contractors.

4.3.2 SPECIAL PROVISIONS

There are areas of a project that are unique to the site that are not necessarily unknown but fall under the term "considerations." These are "considerations" of work items specific to the project that the owner expects the contractor to take into account in preparing the bid. For example, it is possible to encounter deteriorated drums, which are not structurally sound, at a site. If the contractor moves these drums, spills may occur. It is not practical for the owner to be involved in the decision on how every drum should be handled, typically this is left up to the experience of the contractor. However, the owner does not want to be responsible for the contractor's mistakes that result in spills, so the owner under such a scenario would put a provision in the contract requesting that the contract provide a contingency plan for handling spills and that the contractor reflect this in the bid price. This builds a maximum level of care into the contractor's drum handling operation.

The owner may also want to make the contractor aware of other conditions that the owner will not take responsibility for, but that the contractor should take under consideration. These could include provisions for:

- Conducting cleanup operations during the summer and winter months under level "B" protection
- Allowing for periods of inclement weather when scheduling cleanup activities
- Providing enough support equipment (e.g., air compressors) to allow optimum use of on-site personnel with the level "B" protection

- Safety and contingency procedures to handle the discovery of very unique situations not detected in previous sampling activities or field work (e.g., radioactive material which may require involvement of the Nuclear Regulatory Commission)

Experienced contractors should be familiar with these and other standard operating conditions at tank and drum sites; however, it is in the owners best interest to include such items in the contract.

4.4 DESIGN REQUIREMENTS

As stated previously, the bid document presents the basis for conducting project design and implementation. In general, a tank and drum remedial design will contain the General Condition section; the up-front boilerplate or contractual language similar to most construction projects. The next section of source of information is the Technical Specifications section which outlines specifically how the work will be conducted. Table 4-1 is a typical table of contents of the Technical Specifications section. Much of the material under Divisions 1 and 2 present the basic project requirements, which closely coincides with the lump sum items. Division 13 focuses on the special conditions of tank and drum waste and details how these materials are to be handled. Because each drum probably contains waste with unique characteristics, the common basis for design and specifications for tanks and drums is health and safety.

Drums are handled individually by specially designed equipment. All drums are sampled and tested for reactivity and potential compatibility. Drums on-site are probably not Department of Transportation (DOT) approved; therefore, if an individual container is to be removed, it must be repacked or overpacked. To the maximum extent possible, compatible wastes are consolidated and the original drum is crushed for disposal as bulk waste material at secure land disposal facilities. Depending upon drum conditions, empties could be recycled once strict regulatory requirements have been met (see 49 CFR 173.28).

TABLE 4-1
TABLE OF CONTENTS FOR DRUM DISPOSAL
TECHNICAL SPECIFICATIONS

DIVISION 1 - GENERAL REQUIREMENTS

01010	Summary of Work
01018	Site Utilities
01030	Special Project Procedures
01060	Regulatory Requirements
01150	Measurement and Payment
01203	Job Site Administration
01300	Submittals
01590	Temporary Facilities
01700	Contract Closeout

DIVISION 2 - SITE WORK

02100	Site Preparation
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DIVISION 13 - SPECIAL CONDITIONS

13571	Drum Handling Protocol
13572	Drum Sampling Protocol
13573	Bulking and Consolidation Protocol (Analytical Procedures Included)
13574	Securing of Radioactive Waste
13575	Securing of High Hazard Waste
13576	Disposal of Chemical Waste
13577	Collection and Handling of Sludges
13578	Transport of Hazardous Material
13579	Sorting, Identification, Packing and Disposal of Packaged Laboratory Chemical Wastes (Lab Packs)
13580	Securing, Identification, Transport, and Disposal of Pressurized Cylinders Containing Toxic, Explosive, and/or Other Material

APPENDIX

Waste Transport Route
Summary of Waste Categorizations Found On-Site
Personnel Safety/Protection Standards
Special Category of Wastes for Disposal

A	High PCB (>500 ppm), Low Flashpoint Liquids
B	PCB-Contaminated Solids
C	Waste Resins
D	Glycols
E	Classification of Sludge Materials

5.0 REFERENCE GUIDE

The references included in this section are organized according to the section titles of this guidance manual. References are not duplicated even though many apply to several areas. In searching for additional material on a particular subject, do not limit your search to the section headings covering your specific area of interest. Some sections do not have additional referenced material and therefore are not listed. Review the references listed under other headings to complete your search within this manual. Some references are cross referenced when the reference is particularly applicable to more than one section.

Note that Section 3.3.1 contains a lengthy compilation of articles regarding potential alternative technologies that may be considered while searching for available alternative remedial actions. The list is intentionally long to provide the users of this manual with the wide range of alternatives available and to stimulate additional creative thinking along the lines of alternative treatment and disposal techniques, especially for alternatives to land burial of hazardous wastes.

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APPENDIX A

EXAMPLE OF A SITE PERSONNEL
PROTECTION AND SAFETY EVALUATION FORM
FOR USE DURING
INITIAL SITE VISITS

SITE PERSONNEL PROTECTION & SAFETY EVALUATION FORM

PAGE 1 OF 6

REM II DOC. NO.

EPA WA NO.

SITE

EPA REGION

LOCATION

EVALUATOR

SITE DESCRIPTION

SITE MAPS ATTACHED ☐

BACKGROUND ENVIRONMENT

AIR

SURFACE WATER

SOIL

GROUNDWATER

ADDITIONAL HAZARDS ON-SITE

INFORMATIONAL SOURCES USED

REM II DOC. NO. 1

[illegible]

SITE PERSONNEL PROTECTION & SAFETY EVALUATION FORM

PAGE 3 OF 8

REM II DOC. NO.

[illegible]

SITE PERSONNEL PROTECTION & SAFETY EVALUATION FORM

PAGE 4 OF 8

REM II DOC. NO.

SITE PERSONNEL PERSONNEL	SITE ACTIVITY
NAME	SS. NO.
FIRM	REGION
LEVEL OF PROTECTION	CONTINGENCY
VERIFY	()
()	()
()	()
()	()
()	()
()	()
()	()
()	()
()	()
()	()

PERSONNEL PROTECTIVE EQUIPMENT

VERIFY

()

()

()

()

()

()

()

()

FIELD MONITORING EQUIPMENT

VERIFY

()

()

()

()

()

()

()

()

DECON _____

PAGE 5 OF 6

SITE PERSONNEL PROTECTION & SAFETY EVALUATION FORM

REM II DOC. NO. _____

CONTINGENCY CONTACTS		● DENOTES REQUIRED INFORMATION	
AGENCY	CONTACT	PHONE NO.	AGENCY
● FIRE DEPARTMENT	_____	_____	STATE POLICE
POLICE DEPARTMENT	_____	_____	F.A.A.
HEALTH DEPARTMENT	_____	_____	CIVIL DEFENSE
● POISON CONTROL CENTER	_____	_____	● ON SITE COORDINATOR
● STATE ENVIRONMENTAL AGENCY	_____	_____	24 HR. HOTLINE FOR TREATMENT OF TOXIC EXPOSURE
● EPA REGIONAL OFFICE	_____	_____	(513) 421-3063
● EPA ERT, ICOM	_____	_____	
● STATE SPILL CONTRACTOR	_____	_____	

MEDICAL EMERGENCY	
NAME OF HOSPITAL _____	ADDRESS _____ PHONE NO. _____
NAME OF CONTACT _____	ADDRESS _____ PHONE NO. _____
MAP OR ROUTE TO HOSPITAL _____	
TRAVEL TIME FROM SITE (MINUTES) _____	
DISTANCE TO HOSPITAL (MILES) _____	NAME OF 24 HR. AMBULANCE SERVICE _____

SITE PERSONNEL PROTECTION & SAFETY EVALUATION FORM**PAGE 6 OF 6****REM II DOC. NO.****SEF REVIEW**

I have read, understood, and agreed with the information set forth in this Personnel Protection and Safety Evaluation Form (and attachments) and discussed in Presite Visit Health and Safety briefing.

S.H.S.C. SIGNATURE**DATE****R.H.S.S. SIGNATURE****DATE****COMMENTS:****COMMENTS:****SITE PERSONNEL****SITE H & S BRIEFING****CONDUCTED AT****BY****ON****BRIEFING TOPICS****H.S.M. APPROVAL****DATE****REM II H & S INPUT BY****DATE**

APPENDIX B

DRUM HANDLING, DRUM SAMPLING, SPECIAL WASTE HANDLING,
AND TANK SAMPLING PROTOCOLDrum and Special Waste Handling Protocol

- A Personnel involved in handling and transporting drummed waste shall work in teams containing no fewer than two people. Visual contact shall be maintained between members of the working team at all times. All team members shall be able to communicate between themselves and with the Safety Officer by two-way radio at all times on the work site.
- B Preliminary Classification
1. Prior to physically handling a drum, the following preliminary classifications check list shall be completed:
 - a. Is the drum radioactive?
 - b. Does the drum exhibit leakage or deterioration, i.e., is it unsound?
 - c. Does the drum exhibit apparent internal pressure?
 - d. Is the drum empty?
 - e. Does the drum contain markings which would indicate that the contents are potentially explosive?
 2. The results of the preliminary classification checklist shall dictate which specific procedures specified below shall be followed.
- C Leaking or Deteriorated Drums
1. The contents of drums that exhibit leakage or apparent deterioration such that movement will cause rupture (determined by the Safety Officer) shall immediately be transferred to a repack drum. Equipment, including transfer pumps used in the repack operation, shall be of explosion proof construction.
 2. Leaking drums containing sludges or semi-solids, drums that are structurally sound but which are open and contain liquid or solid waste, and drums which are deteriorated but can be moved without rupture, shall be immediately placed in overpack containers.

D Bulged Drums

1. Drums which potentially may be under internal pressure, as evidenced by bulging, shall be sampled in place. Extreme care shall be exercised when working with and adjacent to potentially pressurized drums.
2. Should movement of a pressurized drum be unavoidable, handling shall be by a grappler unit constructed for explosive containment. The bulged drum shall be moved only as far as necessary to allow seating on firm ground or shall be carefully overpacked.
3. Openings into pressurized drums shall be plugged and the bung holes fitted with pressure venting caps set at 5 psi release.

E Drums Containing Explosive or Shock Sensitive Waste

1. Drums that contain wastes that have been identified by sampling, or are suspected by visual examination to be explosive in nature, shall be handled with extreme caution. Initial handling shall be by a grappler unit constructed for explosive containment. Drums shall be palletized prior to transport to high hazard interim storage and disposal area.
2. If at any time during remedial activities, an explosive, pursuant to provisions of Title 18, U.S. Code, Chapter 40 (Importation, Manufacture, Distribution, and Storage of Explosive Materials, 1975 Explosives List) is identified, it should be secured and the appropriate state and federal agencies notified.
3. Identification of an explosive substance during the course of a remedial action is usually based on the experience of the on-site personnel. Potentially explosive materials usually may be identified by their physical characteristics -- texture, color, density, etc., as well as the way they are packaged or labeled. Most explosives are solids. In some cases they are packaged in water-tight containers to exclude water, while in other cases they are packaged wet to preclude explosion.
4. Prior to handling or transporting drums containing explosive wastes, personnel working in the area shall be removed to a safe distance. Continuous contact with the communication base shall be maintained until handling or transporting operations are complete. An audible siren signal system, similar to that employed in conventional blasting operations, shall be used to signify the commencement and completion of explosive waste handling or transporting activities.

F Drums Containing Radioactive Waste

1. Drums containing radioactive wastes shall not be handled until radiation levels have been determined by an initial field survey conducted by the contractor. Survey shall include direct gamma readings and laboratory analysis of drum surface wipe samples.

2. Depending on the level of radiation encountered, handling and transport may require special shielding devices to protect personnel. Following handling and transport, equipment used shall be surveyed by the Safety Officer and decontaminated to background levels prior to recommencing work. Surveys shall also be made of the ground surface in the vicinity of original drum storage to identify potential soil contamination by spilled or leaked radioactive waste. Prior to recommencing work in the area, radioactive soil areas shall be isolated to prevent tracking of radioactive contaminants about the site.

G Packaged Laboratory Wastes (Lab Packs)

1. Drums known or suspected of containing discarded laboratory chemicals, reagents or other potentially dangerous materials in small volume, or individual containers shall be handled with extreme caution. Until otherwise categorized, they shall be considered explosive or shock sensitive wastes. Initial handling shall be by a grappler unit constructed for explosive containment. Drums shall be palletized and overpacked if required prior to transport to the Lab Pack staging for sorting, identification, repacking and/or stabilization.
2. Prior to handling or transporting Lab Packs from the existing drum area, personnel working in the immediate area shall be removed to a safe distance. Continuous contact with the communication base shall be maintained until handling or transporting operations are complete. An audible siren signal system, similar to that employed in conventional blasting operations will be used to signify the commencement and cessation of Lab Pack handling or transporting activities.

H Air Reactive Wastes

1. If the presence of an air reactive substance is verified or even suspected by a contractor, the material should be immediately segregated and transported to a separate high hazard interim storage and disposal area.
2. Air reactive wastes may be discovered during opening or sampling operations. Air reactive substances normally require special packaging. They may be stored under water or some other liquid to minimize air contact. They may also be found in sealed ampules, corrugated drums, stainless steel canisters, or specially lined drums. Some chemicals, such as white phosphorus or barium oxide, react with oxygen in the air, while others, such as sodium, cesium or various metal hybrids, react with the moisture or water vapor in the air. Many of these compounds are explosive when they come in contact with air or water.

I Gas Cylinders

1. Gas cylinders, when encountered, should be stored and disposed of on a specific case basis depending on the integrity of the cylinders and type of substance they are expected to contain.

J Empty Drums

1. Empty drums containing less than 1 in. of solid residual waste and those resulting from on-site bulking and repack operations shall be loaded by grappler into transport equipment and placed within the empty drum staging area. Residuals, where possible, shall be transferred to repack containers prior to movement. Additional information on the definition of empty drums can be found in 40 CFR 261.7. Also, limitations on the reuse of drums can be found in 49 CFR 173.28.

K General Drum Handling Procedures

1. The handling, movement, and transport of drums should be by use of mechanical equipment only; no drums should be handled manually.
2. Remote drum handling equipment shall consist of a grappler equipped backhoe or front end loader. Drum transportation should be with front end loaders or fork lifts with modified carrying platforms.

Portions of equipment that contact drums or canisters should be constructed of non-ferrous metals or contact portions should be coated or lined to preclude spark generation.

Handling and transport equipment should be equipped with full frontal and side splash and explosion shields. Class ABC fire extinguishers shall be fitted to the body of each piece of equipment.

Equipment should be maintained in first class condition. The ignition manifold and exhaust components shall be maintained to prevent backfiring or generation of sparks within the exhaust gases.

DRUM SAMPLING PROTOCOL**A General Drum Sampling Protocol**

The protocols for drum sampling performed at two NPL sites are presented in Figures I to VII (at the end of the Appendix). These protocols are a systematic plan for the identification, segregation/isolation, consolidation, and bulking of unspecified waste materials stored at an abandoned hazardous waste site. The analytical methods and references for the waste testing are presented in Figure VII. These methods are provided for guidance only. The protocol established herein is designed to provide analytical data, compatibility and consolidation information consistent with cost effective environmentally sensitive removal and disposal of hazardous waste from the site. The quality assurance for these activities should be consistent with the procedures specified in "Enforcement Consideration for Evaluation of Uncontrolled Hazardous Waste Disposal Sites by Contractors" (U.S. EPA, National Enforcement Investigation Center, April 1980).

The following are the standard materials and equipment required for sampling:

1. Personnel protection equipment
2. 500 ml, wide-mouth amber glass bottle with teflon cap liner
3. A uniquely numbered sample identification label affixed to sample container
4. Chain of custody data sheets
5. 4-ft. x 3/4-in. ID glass sampling thief
6. Remotely operated, pneumatic ram or check key device
7. One gallon covered cans half-filled with absorbent (for off-site shipment only)

During the initial reconnaissance and characterization, any customized containers, suspicious looking drums, or drums labeled as containing hazardous materials (explosives, etc.) should be clearly marked for special handling. Maximum care and caution shall be exercised when opening drums containing materials of an unknown origin. A drum should not be moved or opened unless it has been ascertained beyond reasonable doubt that the drum is structurally sound and an external gross gamma scan is negative.

Drums should be sampled in place. All drums and mechanical equipment should be grounded prior to the commencement of sampling. If the bung can be removed, sampling contained liquids shall be by a glass thief, which shall then be broken and discarded within the barrel. A barrel that has a badly rusted bung, or that cannot be sampled as above, shall be safely

entered with a hydraulic penetrating device operated remotely. All openings shall be plugged except during sampling operation.

B Specific Sampling Procedure Using a Glass Thief

1. Remove cover from sample container.
2. Insert glass tubing almost to the bottom of the drum or until a solid layer is encountered. About 1 ft. of tubing should extend above the drum.
3. Allow the waste in the drum to reach its natural level in the tube.
4. Cap the top of the sampling tube with a tapered stopper, ensuring liquid does not come into contact with stopper.
5. Carefully remove the capped tube from the drum and insert the uncapped end in the sample container. Do not spill liquid on the outside of the sample container.
6. Release the stopper and allow the glass thief to drain completely and fill the sample container. Fill the container to about 2/3 of capacity.
7. Remove tube from the sample container, break it into pieces and place the pieces in the drum.
8. Cap the sample container tightly and place prelabeled sample container in a carrier.
9. Replace the bung or place plastic over the drum.
10. Transport sample to on-site laboratory for analysis.

C Sample preservation and packing procedures for drummed waste samples

1. No preservatives shall be used.
2. Place sample in a ziplock plastic bag.
3. Place each bagged container in a 1-gallon covered can containing absorbent packing material. Place lid on can.
4. Mark the sample identification number on the outside of the can.
5. Arrange for the appropriate transportation mode consistent with the type of hazardous waste involved.

D Considerations for Analytical Program

At the certified laboratory, each of the waste phases from all tanks should first be tested for compatibility. Many wastes, when mixed with others, can produce potentially adverse human health and environmental conditions

such as: (1) heat generation, (2) violent reaction, (3) release of toxic fumes and gases, (4) release of toxic substances in case of fire or explosion, (5) fire or explosion, and (6) generation of flammable or toxic gases.

A summary list of potentially incompatible waste materials or components and the adverse consequences of mixing waste in one group with waste in another group is presented in Appendix C. The mixing of a Group A waste with a Group B waste may have the consequences noted.

The results of the compatibility characterization should be used to sort bulk waste into compatibility categories for ultimate disposal. A composite sample of each compatibility category will then be analyzed for all major chemical components.

TANK SAMPLING PROTOCOL

A Regulatory Requirements

1. Guidelines have been developed to ensure the safety of the operations personnel which shall be consulted by the contractor. These are as follows:
 - a. OSHA - "General Duty Clause", Section 5 A-1 of the Occupational Safety and Health Act (Public Law 910596).
 - b. NIOSH - "Criteria for Recommended Standard; Working in Confined Spaces", Publication No. 80-106.
2. In addition, reference material shall also be used, such as the Anderson National Standard Institute, Inc. (1430 Broadway, New York, NY 10018) "Safety Requirements for Working in Tanks and Other Confined Spaces", ANSI-Z117.1

B Tank Structural Survey

The external structural characteristics of each tank and tanker shall be observed and uniquely recorded and potential sampling points shall be evaluated for safety, accessibility and sample quality.

C Tank Entry Procedure

1. Prior to opening a tank for internal inspection, the tank entry team shall:
 - a. Review safety procedures and emergency contingency plans with the Safety Officer.
 - b. Ensure that tank is properly grounded.
 - c. Remove all sources of ignition from the immediate area.
2. All members of the tank entry team shall be fitted with self-contained breathing apparatus.
3. Each tank shall be mounted using appropriate means and the manway covers removed using non-sparking tools.
4. Obtain and record the following information at each potential sampling location.
 - a. Lower explosion limit (LEL) reading directly above the sampling port and the tank head space.
 - b. Organic vapor concentration directly above the sampling port and in the tank head space.

- c. Percent oxygen concentration directly above the sampling port and in the tank head space.
 - d. Physical characteristics of tank contents (liquid, sludge, or solid).
 - e. Distance from sampling port flange to the surface of tank contents.
 - f. Presence of toxic vapors.
 - g. Accumulation of pyrophoric deposits.
 - h. Ionizing radiation.
 - i. Additional potential physical hazards.
5. After the above information has been obtained, each opening shall be closed and secured.

D Profiling of Contents

- 1. Personal protective equipment and respiratory protection shall be determined by the Safety Officer based on information gained from the reconnaissance work specified above. Minimum protection shall be Level C.
- 2. Material and equipment required for profiling and/or sampling are as follows:
 - a. Personal protection equipment as specified in Health & Safety Plan
 - b. OVA, Organic Vapor Analyzer, or equivalent
 - c. Explosimeter/Oxygen meter
 - d. Geiger counter
 - e. Flashlight (explosion proof)
 - f. Trowel-stainless steel
 - g. Weighted sampler
 - h. Gem scoop
 - i. Bottom sediment sampler
 - j. Aluminum foil
 - k. Glass thief
 - l. Log book

- m. Intrinsically safe high volume blower
 - n. Wide mouth amber glass (550 ml) bottle with teflon cap liner
 - o. Sample identification labels affixed to sample bottle
 - p. Chain-of-Custody forms
 - q. Metal paint can (1 gallon) half-filled with absorbent
 - r. Camera
3. Prior to commencing any profiling, the tank head space shall be cleared of any toxic or explosive vapor concentration using a high volume blower. No work shall start in any tank if the LEL exceeds 10% (as methane).
4. The preliminary safety guidelines outlined above shall be observed.
5. Profiling Procedure
- a. Determine the depth of any and all liquid solid interface using a weighted probe line.
 - b. Determine the depth of any bottom sludge layer using a weighted probe line.
 - c. Collect liquid samples from 1 ft. below the surface, from mid depth of the liquid, and from 1 ft. foot above any bottom sludge layer. Samples shall be collected a weighted bottle sampler (ASTM Method D270).
 - d. Visually compare the three samples. If no visual phase difference is observed, perform field test as required to verify that no phase differences are present in the tank. Field tests selected shall be determined by the type of material found in the tank (organic, aqueous) and include:
 - Specific Conductivity
 - Specific Gravity
 - Refractive Index
 - pH
 - Solubility (water, methanol, methylene chloride)
 - Viscosity
 - e. If any sampling indicated a phase difference, a systematic, interactive sampling procedure shall be performed by halving the distance between two discrepant sampling points until the depth of the phase change can be determined. This phase difference shall be verified by field tests specified in d above.
 - f. Verify the profile information from at least one other access port when possible.

- g. The mutual incompatibility of all phases shall be verified.
- h. Determine the volume of wastes in each phase and the volume and depth of any sludge.

E Sampling Procedure

1. The method utilized to sample the tanks shall be based on the physical characteristics of the material. Liquid materials shall be sampled with a weighted bottle or glass thief; gels and sludges shall be sampled with a scoop or bottom sediment sampler.
2. Liquids shall be sampled as follows:
 - a. Determine the depth to any and all liquid/solid interfaces using a weighted probe line or glass thief.
 - b. Determine the depth of the bottom sludge layer using a weighted probe line or glass thief.
 - c. For liquids with a depth of greater than 5 ft.:
 1. Collect samples from 1 ft. below the surface, from mid depth of the liquid, and from one-foot above any bottom sludge layer. Using a weighted bottle sampler (ASTM Method D270).
 2. If a visual examination of sample indicates phase difference, a systematic, interactive sampling procedure shall be performed by halving the distance between two discrepant sampling points until the depth of the phase change can be determined.
 - d. For liquids with a depth of 5 ft or less:
 1. Collect liquid samples using a glass thief inserted in the full depth of the liquid.
 2. Transfer the liquid sample to a glass sample bottle and dispose of thief in tank.
 3. A maximum of three composite samples shall be obtained from each sampling port.
3. Sludges shall be sampled using a scoop or modified bottom sediment sampler. A maximum of three sludge samples from each sampling port shall be obtained at various depths within the tank.
4. Between each sampling event, the samplers shall be cleaned, rinsed, and dried prior to use.
5. Samples shall be placed in 500 ml wide mouth amber bottles. The bottles shall not be filled beyond 2/3 capacity.

6. Sample bottle openings shall be covered with aluminum foil and capped with teflon lined caps.
7. Sample identification information and locator information shall be recorded in a log book. A descriptive narrative shall accompany each sample obtained from the tanks.

Figure 1. Waste segregation protocol.

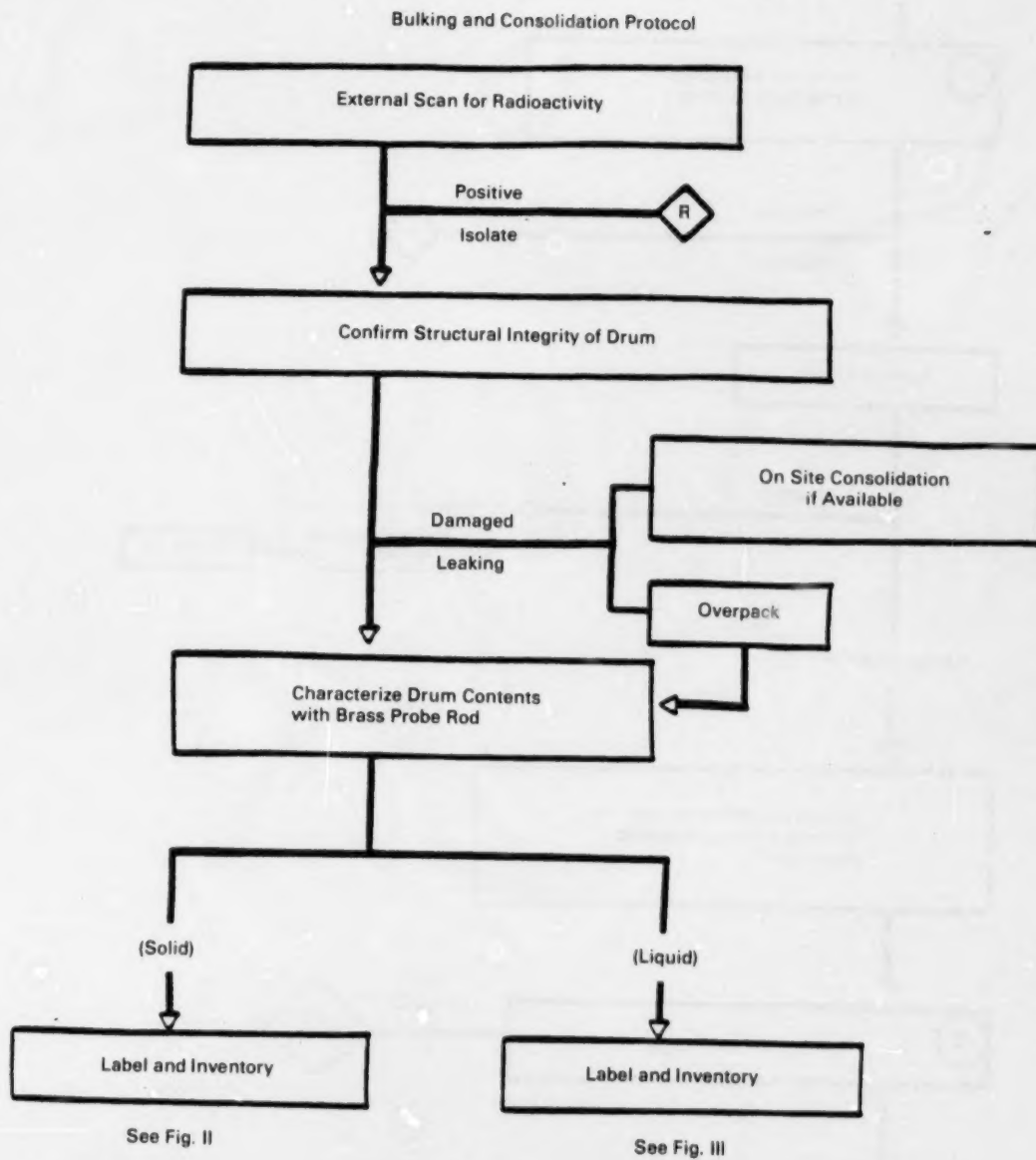
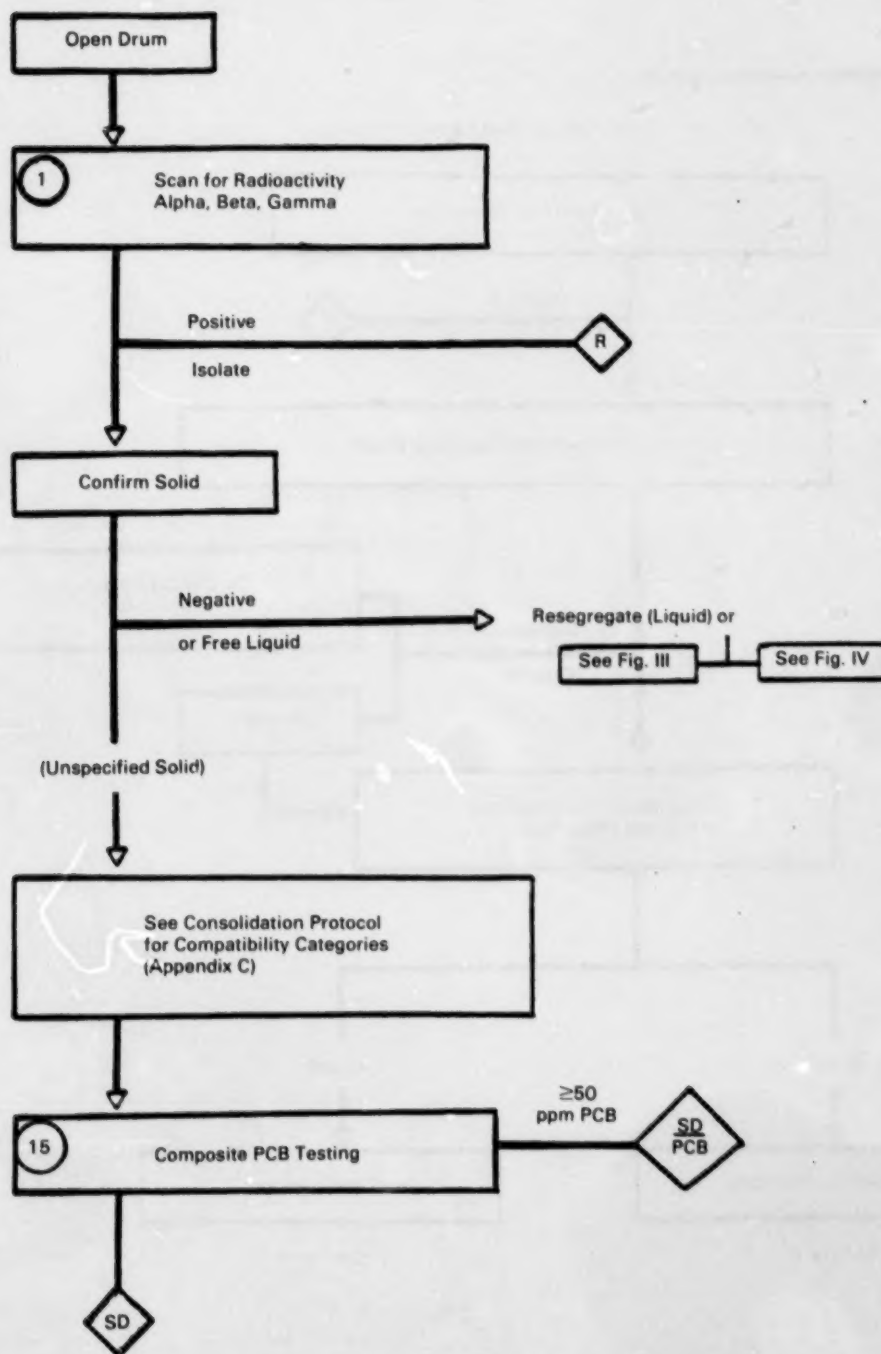


Figure II. Solid materials.

Bulking and Consolidation Protocol



For SD and $\frac{SD}{PCB}$ determine flashpoint (17) for ultimate disposal requirements for solid materials.

Figure III. Liquid materials.

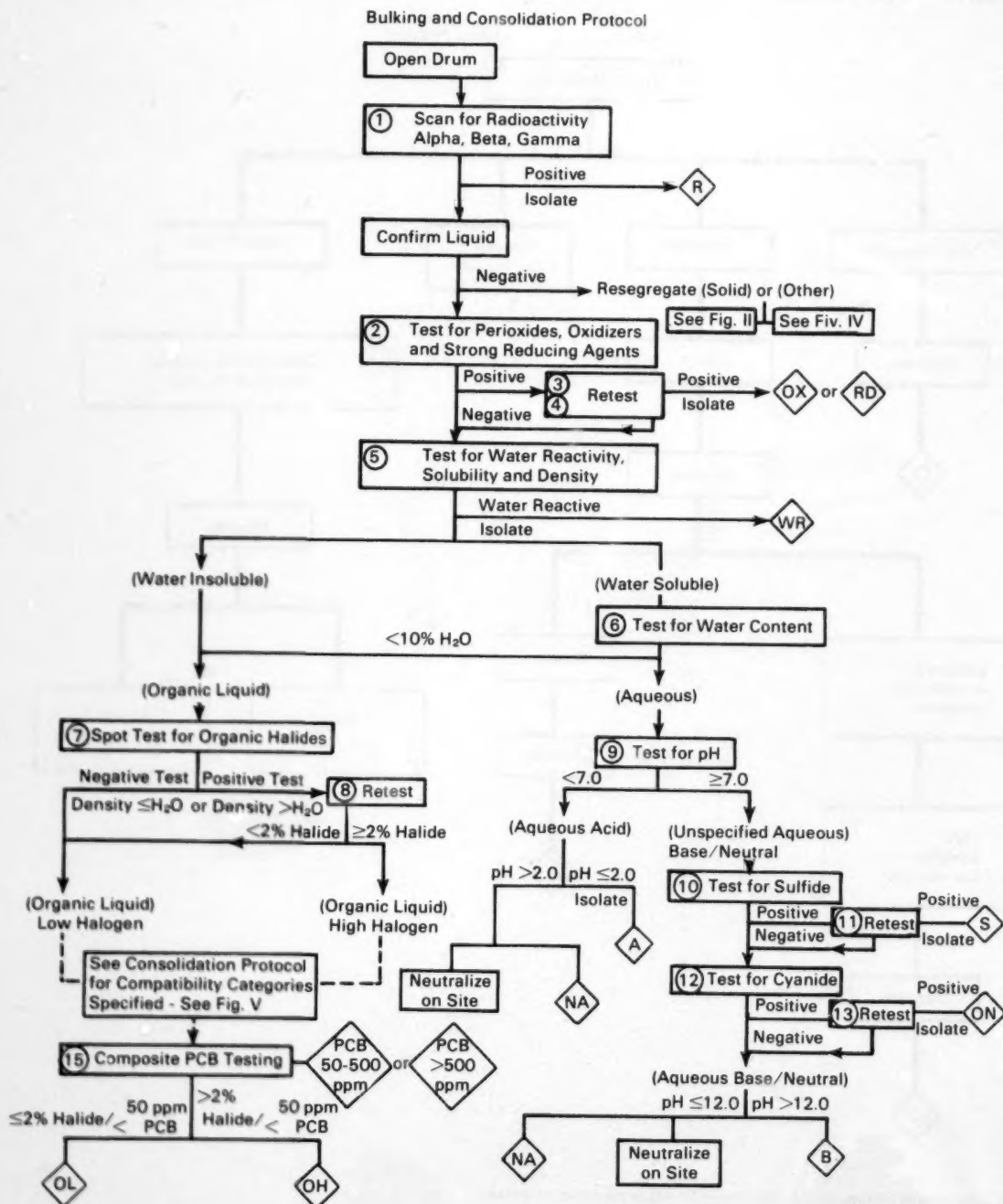
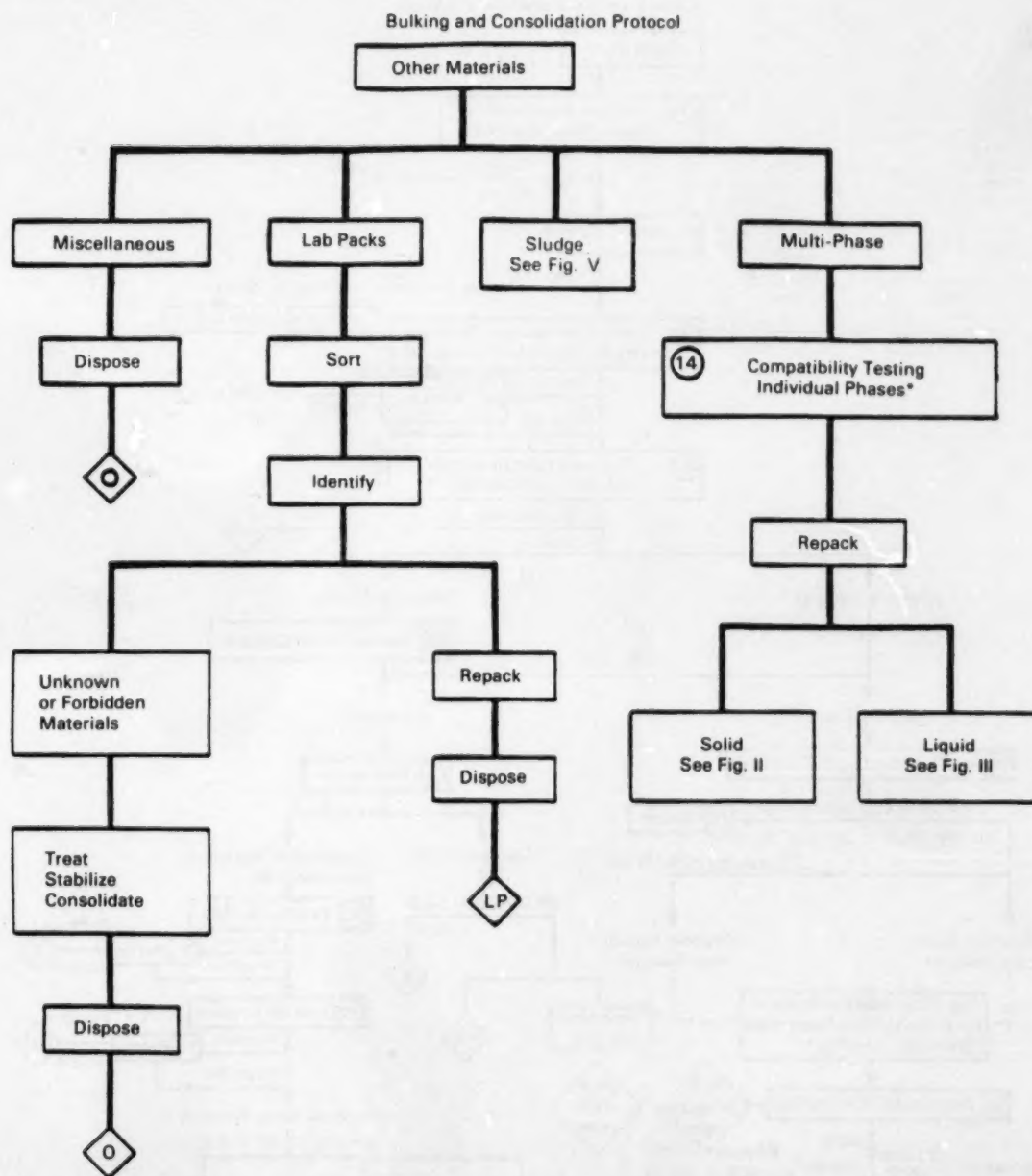


Figure IV. Other materials



*If phases are incompatible, they must be separated and repacked.

Figure V. Consolidation protocol for compatibility categories specified

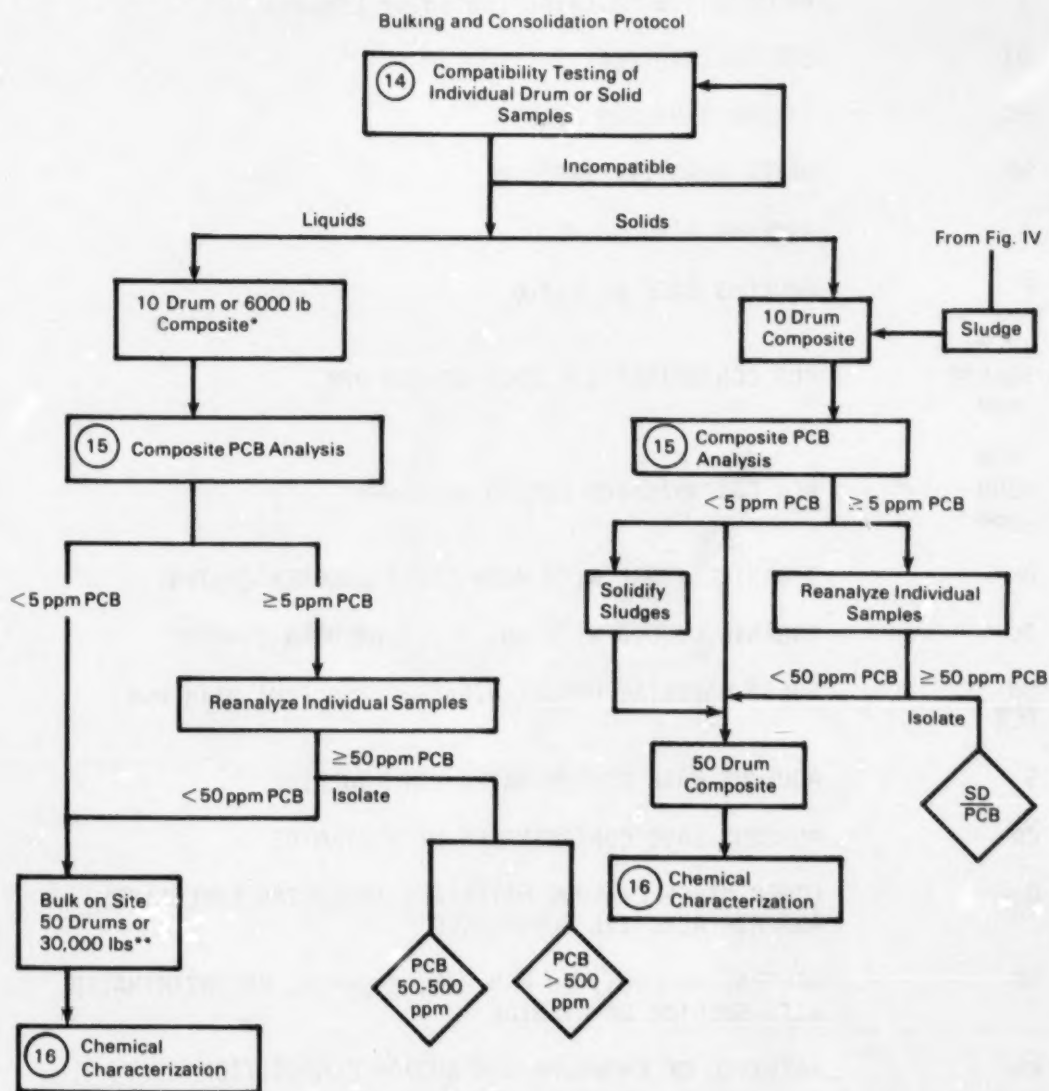


FIGURE VI

DISPOSAL CATEGORIES
(In diamonds on Figures I to V)

R	RADIOACTIVE MATERIAL (Solid or Liquid)
OX	STRONG OXIDIZER
RD	STRONG REDUCING AGENT
WR	WATER REACTIVE MATERIAL
A	AQUEOUS ACID pH <2.0
B	AQUEOUS BASE pH >12.0
PCB 50-500 ppm	PCB CONTAMINATED LIQUID 50-500 PPM
PCB >500 ppm	PCB CONTAMINATED LIQUID >500 PPM
OH	ORGANIC LIQUID WITH HIGH (>2%) HALOGEN CONTENT
OL	ORGANIC LIQUID WITH LOW (<2%) HALOGEN CONTENT
<u>SD</u> <u>PCB</u>	SOLID MATERIAL UNCONTAMINATED (<50 PPM) WITH PCB
S	AQUEOUS BASE CONTAMINATED WITH SULFIDE
CN	AQUEOUS BASE CONTAMINATED WITH CYANIDE
O	OTHER MISCELLANEOUS MATERIALS INCLUDING EXPLOSIVES AND AIR REACTIVE SUBSTANCES
NA	NEUTRAL AQUEOUS, 50 PPM PCB, 2<pH<12, UNCONTAMINATED WITH SULFIDE OR CYANIDE
KN	MATERIAL OF KNOWN ORIGIN AND/OR COMPOSITION

FIGURE VII
ANALYTICAL METHODS
(In circles in Figures I to V)

<u>DESIGNATION</u>	<u>METHOD</u>	<u>REFERENCE</u>
1	RADIOACTIVITY, ALPHA, BETA, GAMMA	*MUHWS (110)
2	OXIDATION REDUCTION POTENTIAL (ORP)	MUHWS (112)
3	CONFIRMATION TEST FOR PEROXIDES AND OTHER OXIDIZING AGENTS	DCP (5.9)
4	CONFIGURATION TEST FOR REDUCING AGENTS	*TBQIA (564)
5	TEST FOR WATER REACTIVITY AND SOLUBILITY	DCP (5.1)
6	TEST FOR WATER CONTENT	DCP (5.20)
7	SPOT TEST FOR PRESENCE OF HALOGENS	*SIOC (174)
8	TEST FOR HALOGEN CONTENT	DCP (5.6)
9	pH ANALYSIS	DCP (J5.3)
10	SPOT TEST FOR SULFIDE	*LEAD ACTIVE PAPER
11	CONFIRMATION TEST FOR SULFIDE	DCP (5.50)
12	SPOT TEST FOR CYANIDE	*DCP (5.4)
13	CONFIRMATION TEST FOR CYANIDE	*SM (412E)
14	COMPATIBILITY PROCEDURE	DCP (5.8)
15	COMPOSITE PCB ANALYSIS	DCP (5.7)
16	CHEMICAL CHARACTERIZATION AS REQUIRED FOR DISPOSAL	Section 13573, 1.03B
17	IGNITABILITY	SW-846 (1010, 1020)

*See Analytical Notes.

FIGURE VII

ANALYTICAL METHODS
(Continued)

- DCP - Drum Consolidation Protocol, A Hazardous Waste Site Management Plan (Chemical Manufacturers Association, Washington, D.C., 1984)
- MUHWS - National Conference on Management of Uncontrolled Hazardous Waste Sites (U.S. EPA Hazardous Materials Control Research Institute), October 1981
- SIOC - The Systematic Identification of Organic Compounds, Shriner et al., 5th Edition, Jon Wiley & Sons, New York, NY, 1964
- TBQIA - Text Book Quantitative Inorganic Analysis, Kolthoff, I.M., 3rd Edition, McMillan Co.
- SM - Standard Methods for Examination of Water & Waste Water, 15th Edition, 1980
- SW-846 - Test Methods for the Evaluation of Solid Waste Physical/Chemical SW-846, U.S. EPA, 1984.

EXAMPLE OF A
BULKING AND CONSOLIDATION PROTOCOL

Purpose

The concept of the bulking and consolidation protocol is to segregate wastes based on water content, acidity, water solubility, and reactivity in anticipation of ultimate disposal.

Technique

The protocol (a) assumes the waste contains complex mixtures of solids and liquids of unknown source and concentration; (b) subdivides the liquids into general disposal categories; (c) determines that wastes within a group are compatible by actual compatibility testing; (d) provides that each compatibility group composite is tested for PCB to ensure that contaminated material is disposed of properly; and (e) provides that compatible materials are then bulked in batches for disposal ("Disposal Units") - for liquids and solids, 50 drums or 30,000 lbs, respectively. All solid material should be moved off-site in individual containers only.

Other points considered in this approach include the following:

- Radioactive waste shall be identified both at the initial stage of site evaluation as well as during the sampling of individual containers.
- Waste containing peroxides, and toxic gas-forming compounds (cyanide, sulfide) should be identified and segregated for special treatment. Consolidation at a later date may be advisable but only after performing the compatibility testing procedure as outlined in the protocol.
- Tests for water solubility, reactivity and water content shall be used to classify organic, aqueous-soluble organic and inorganic wastes. (The organic/aqueous and aqueous wastes include emulsions). Very often density is an indication of structure (i.e., if liquid is heavier than water, halogen is probably present).
- Samples shall be tested for organic halogen content, however, the test procedures done in the field only detect gross amounts; 1-2 percent. Samples shall be retested for PCBs before disposal, and

before one contaminates larger batches. This is why lab size consolidated mixtures are tested prior to consolidation to avoid contamination.

- Wastes containing multiple phases shall be treated separately and all phases analyzed.
- The compatibility test shall be performed on-site by mixing small samples (left over from analyses). Visual observation for precipitation, or phase separation and temperature measurement (to test for chemical reactions) shall be made.
- All of these analytical tests shall be performed on-site using relatively simple procedures and equipment. Analysis for EP toxicity and PCBs shall be done by the contractor.
- The analytical procedure for determining halogen content shall determine gross halogen content (>1%). Tests for PCBs shall be done to determine ultimate disposal if disposal is in a non-PCB approved incinerator. Tests shall be conducted on the lab composites prior to mixing drum contents so one can isolate the contaminating container and/or change the mixing sequence as required to avoid PCB contamination.

A simplified logic diagram for the consolidation protocol is presented in Figure 1.

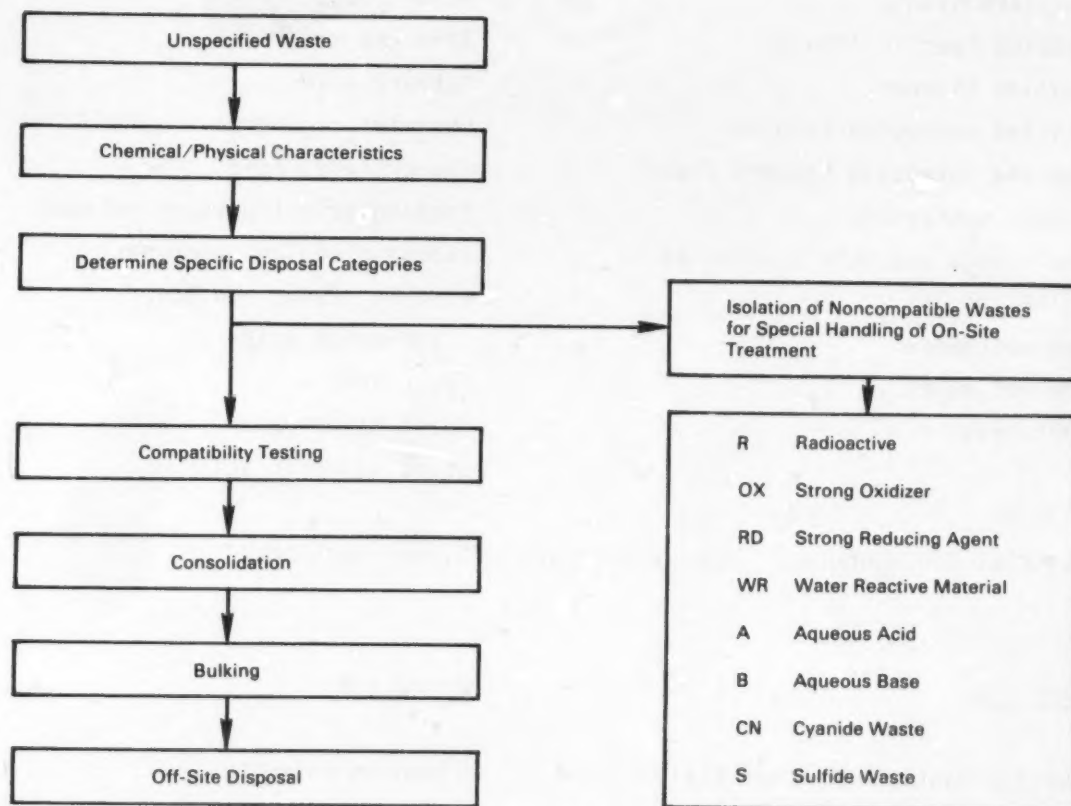
Chemical characterization in anticipation of ultimate disposal, is designed to test composite samples taken from individual drum sample aliquots. No bulking or consolidation should be done until the result of the analyses of the "lab scale" composite are reviewed to preclude the inadvertent contamination of a consolidated lot by a highly concentrated component such as PCB. The testing and analytical procedures to be used on the consolidated materials should be that required for transport and disposal of material which will vary dependent on the method of disposal.

Following chemical characterization, those wastes that for chemical or physical reasons cannot be bulked should be consolidated in approved drums pending disposal. The Contractor should, as far as practical, use the full volume of each drum. Shipment from site of partially empty drums of solid waste should be kept at a minimum.

Limitations

Not applicable

Figure 1. Simplified logic diagram waste consolidation protocol.



COMPATIBILITY OF HAZARDOUS WASTE GROUPS

Group 1-A

Acetylene sludge
Alkaline caustic liquids
Alkaline cleaner
Alkaline corrosive liquids
Alkaline corrosive battery fluid
Caustic wastewater
Lime sludge and other corrosive
alkalies
Lime wastewater
Lime and water
Spent caustic

Group 1-B

Acid sludge
Acid and water
Battery acid
Chemical cleaners
Electrolyte, acid
Etching acid liquid or solvent
Liquid cleaning compounds
Picking liquor and other
corrosive acids
Spent acid
Spent mixed acid
Spent sulfuric acid

Potential consequences: Heat generation, violent reaction.

Group 2-A

Asbestos waste, and other toxic
wastes
Beryllium wastes
Unrinsed pesticide container
Waste pesticides

Group 2-B

Cleaning solvents
Data processing liquid
Obsolete explosives
Petroleum waste
Refinery waste
Retrograde explosives
Solvents
Waste oil and other flammable
and explosive wastes

Potential consequences: Release of toxic substances in case of fire or
explosion.

Group 3-A

Aluminum
Beryllium
Calcium
Lithium
Magnesium
Potassium
Sodium
Zinc powder and other reactive
metals and metal hydrides

Potential consequences: Fire or explosion; generation of flammable hydrogen gas.

Group 3-B

Any waste in Group 1-A or 1-B

Group 4-A

Alcohols
Water

Potential consequences: Fire, explosion, or heat generation; generation of flammable or toxic gases.

Group 4-B

Any concentrated waste in
Groups 1-A or 1-B
Calcium
Lithium
Metal hydrides
Potassium
Sodium
SO₂, Cl₂, SOCl₂, PCl₃, CH₃,
SiCl₃ and other water
reactive wastes

Group 5-A

Alcohols
Aldehydes
Halogenated hydrocarbons
Nitrated hydrocarbons and other
reactive organic compounds and
solvents
Unsaturated hydrocarbons

Group 5-B

Concentrated Group 1-A or 1-B
wastes
Group 3-A wastes

Potential consequences: Fire, explosion or violent reaction.

Group 6-A

Spent cyanide and sulfide
solutions

Group 6-B

Group 1-B wastes

Potential consequences: Generation of toxic hydrogen cyanide
or hydrogen sulfide gas.

Group 7-A

Chlorates and other strong
oxidizer
Chlorine
Chlorites
Chromic acid
Hypochlorites
Perchlorates
Permanganates
Peroxides

Group 7-B

Acetic acid and other organic
acids
Concentrated mineral acids
Group 2-B wastes
Group 3-A wastes
Group 5-A wastes and other
flammable and combustible
wastes

Potential consequences: Fire, explosion, or violent reaction.

Source: "Law, Regulations and Guidelines for Handling of
Hazardous Waste."
California Department of Health, February 1975.